THE JOURNAL OF GAS LIGHTING
WATER SUPPLY & SANITARY IMPROVEMENT

VOL. LIX. No. 1520.] LONDON, JUNE 28, 1892. [44TH YEAR. PRICE 6d.

GAS AND WATER PIPES.

1¼ to 12 IN. BORE.

THOMAS ALLAN & SONS,

Bon Lea Foundry,

SOUTH STOCKTON-ON-TEES.

ALSO MANUFACTURERS OF
SANITARY & RAIN-WATER PIPES, HOT WATER PIPES, STABLE FITTINGS, RANGES, STOVES, And GENERAL CASTINGS.

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Telegrams:
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— ESTABLISHED 1830. —

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Manufacturers & Contractors.

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PATENT ANTIMONY PAINT,

Parker's Imperial Black Varnish,

Oxide Paints, Oils, and General Stores for Gas and Water Works.

WORKS
ORMSIDE STREET, OLD KENT ROAD,
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WOLSTON'S

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DARTMOUTH, DEVON.

Lanemark Coal Co.,

LIMITED.

LANEMARK CANNEL

AND GAS COALS.

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NEW CUMNOCK, N.B.

Shipping Ports: All the principal Scotch Ports.

GASHOLDERS

C. & W. WALKER

Are now erecting a four-lift Holder of about 8 MILLION cubic feet,

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PURIFYING MACHINES;

CO_2 AND TAR-EXTRACTING WASHERS; SCRUBBERS;

SULPHATE & SULPHUR PLANT;

PATENT SELF-SEALING RETORT MOUTHPIECES;

LIFTING APPARATUS; CENTRE AND FOUR-WAY VALVES;

SOLE MANUFACTURERS OF WECK'S PATENT CENTRE-VALVE;

PATENT TAR PLANT; CONDENSERS;

SLIDE VALVES; TAR BURNERS; &C., &C.

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ADDRESSES:

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LATE

FLETCHER AND MURPHY,

GARRATT STREET WORKS, OLDHAM ROAD, MANCHESTER,

Manufacturers of

IMPROVED CONSUMERS' WET GAS-METERS

IN CAST-IRON CASES,

THE UNVARYING WATER-LINE GAS-METER,

AND

IMPROVED DRY GAS-METERS.

SPECIALITY: PATENT CASH PREPAYMENT METERS.

S. OWENS & CO., Hydraulic, Gas, & General Engineers, WHITEFRIARS ST., LONDON, E.C.

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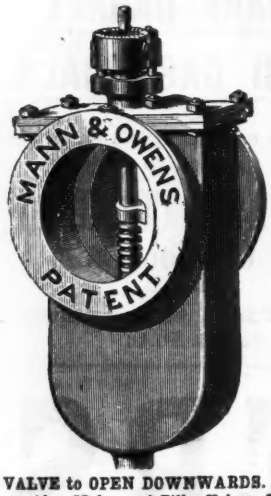
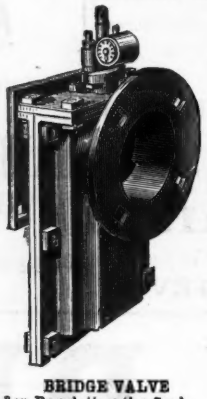
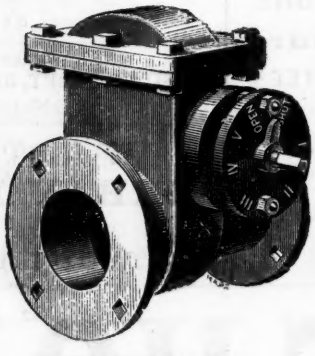


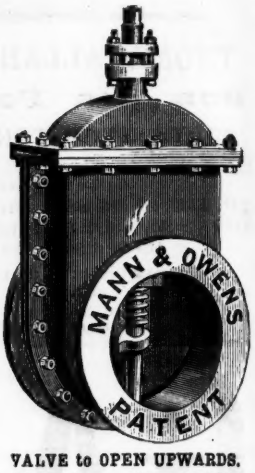
VALVE to OPEN DOWNWARDS.



BRIDGE VALVE for Regulating the Seal of Hydraulic Mains.



FULL-WAY RACK AND PINION VALVE.



VALVE to OPEN UPWARDS.

Also Makers of Pillar Valves, Self-acting Bye-pass Valves, Outside Rack and Pinion Valves, Hydraulic Main-Valves, Disc-Valves, and Special Valves of all kinds. Improved Gas-Exhausters, Steam-Engines, Steam-Cranes, Boilers. Blake's Patent Steam-Pumps for Tar, Water, and Ammoniacal Liquor. Hydraulic Coal-truck Lifts, Hydraulic Cranes, Hydraulic Apparatus for Lifting Purifier-Covers, and every description of Pumping Apparatus, &c., suitable for use in Gas-Works, made to order.

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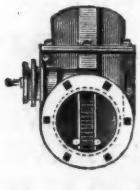
NEWTON, CHAMBERS, & CO., LIMITED,

THORNCLIFFE IRON-WORKS, near SHEFFIELD,

MANUFACTURERS OF

SLIDE VALVES,
WITH RACK & PINION
OR
Internal or External
SCREWS, of all Sizes.

GASHOLDERS,
AND
Gasholder Tanks.



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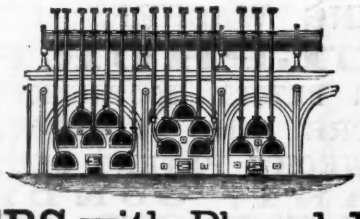
of every description.

Iron Roofs, Columns, Girders, Floor Plates and Tools, &c.



WROUGHT AND CAST IRON

CONDENSERS, SCRUBBERS, & WASHERS,

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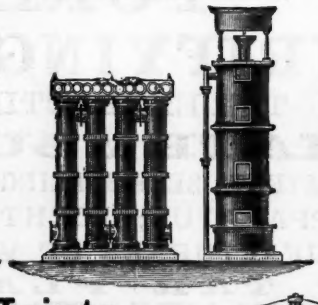

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for working Purifiers.

Also Bye-Pass & Stop Valves.

PURIFIERS with Planed Joints,

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WOOD GRIDS.

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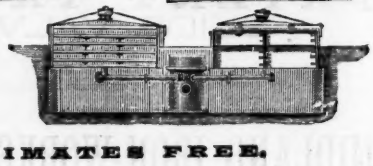

DESIGNS, SPECIFICATIONS, AND ESTIMATES FREE.

Pig Iron (*Special Quality*) for ENGINE CYLINDERS, &c.

GAS COAL FAMOUS FOR ITS UNRIVALLED EXCELLENCE.

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GAS ENGINEERS AND CONTRACTORS,

Telegrams: "GASOMETER GLASGOW."

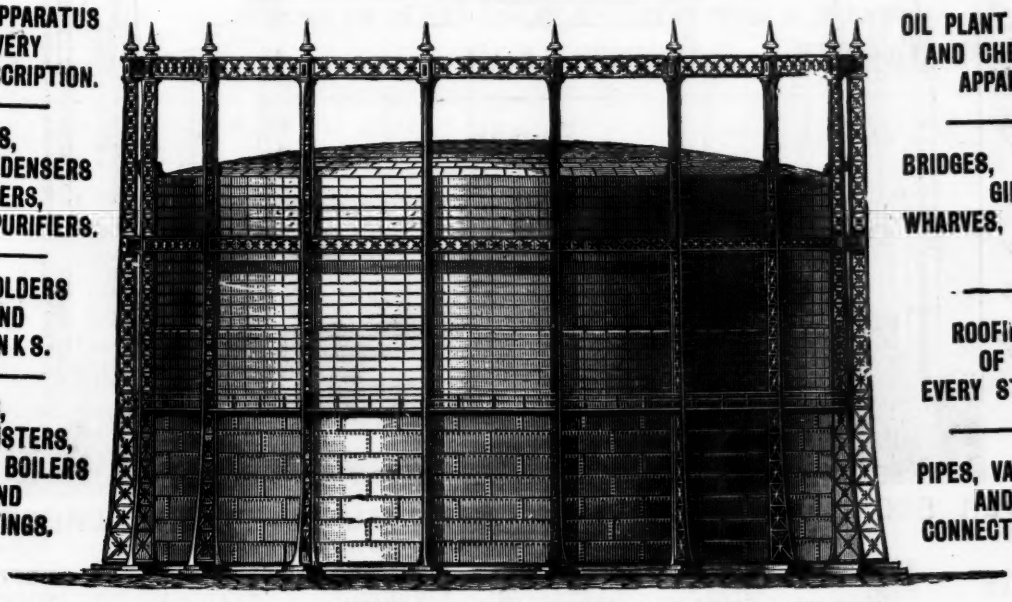
GLASGOW.

GAS APPARATUS OF EVERY DESCRIPTION.

RETORTS, CONDENSERS SCRUBBERS, PURIFIERS.

GASHOLDERS AND TANKS.

ENGINES, EXHAUSTERS, STEAM BOILERS AND FITTINGS.



OIL PLANT AND CHEMICAL APPARATUS.

BRIDGES, GIRDERS WHARVES, PIERS.

ROOFING OF EVERY STYLE.

PIPES, VALVES, AND CONNECTIONS.

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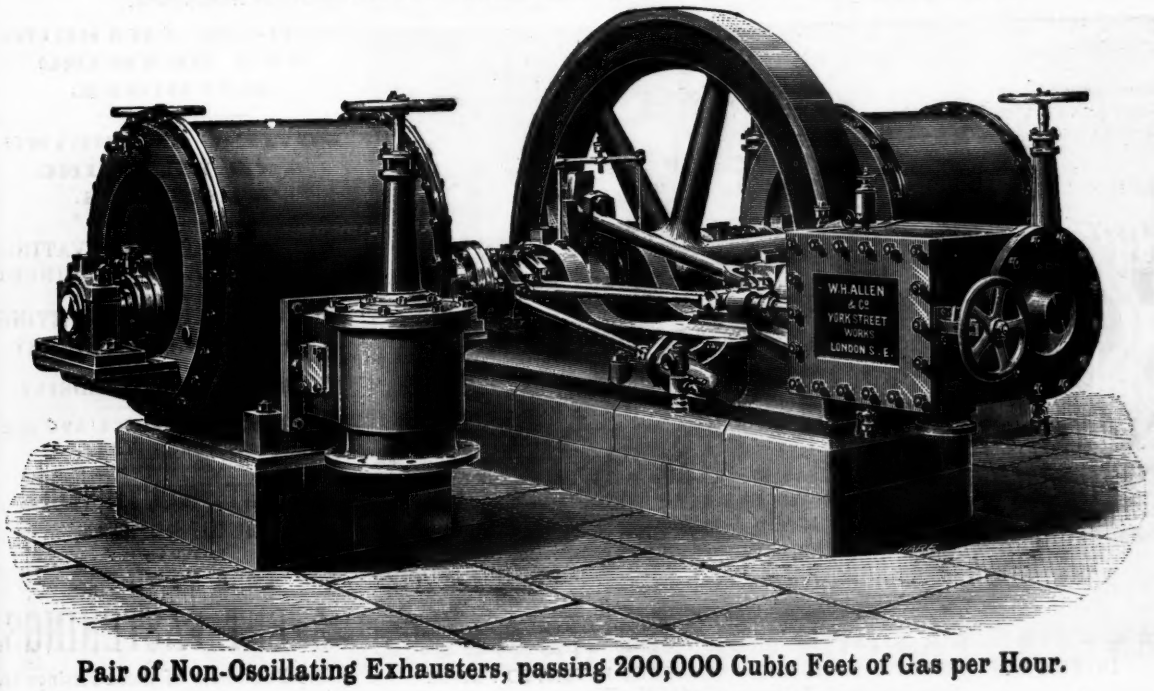
W. H. ALLEN & CO.,

York Street Works, LAMBETH, LONDON, S.E.,

MAKERS OF THE MOST IMPROVED FORM OF

GAS EXHAUSTING MACHINERY.

BEALE'S PATENT—ALLEN'S COMBINED SYSTEM.

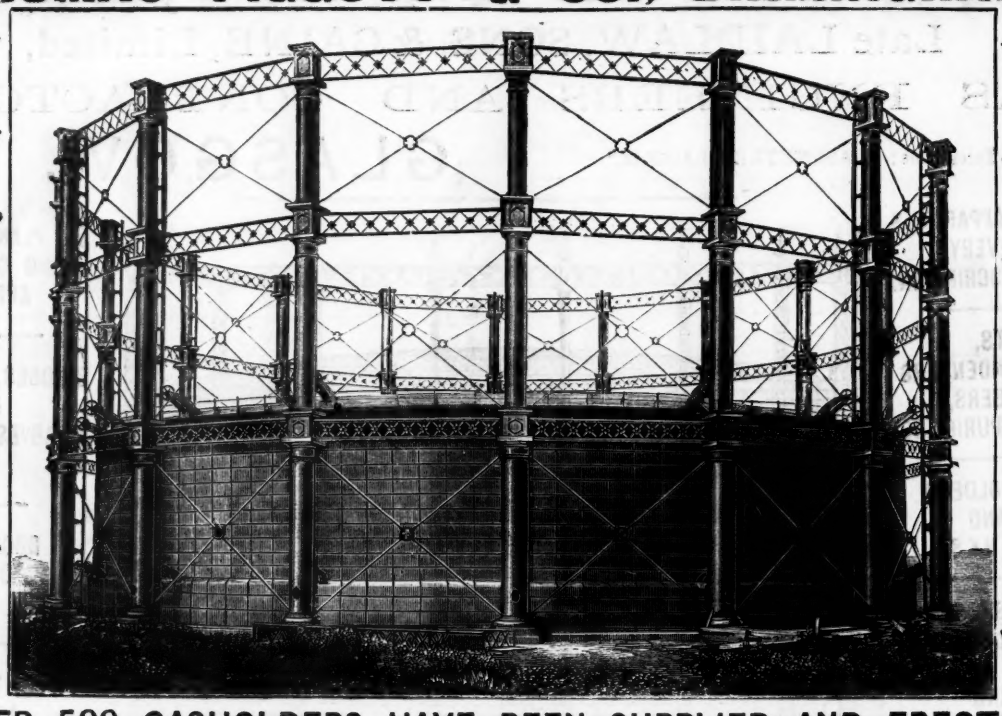


Pair of Non-Oscillating Exhausters, passing 200,000 Cubic Feet of Gas per Hour.

THOMAS PIGGOTT & CO., BIRMINGHAM.

LONDON OFFICE: ST. THOMAS APOSTLE, E.C.

GAS PLANTS, BOILERS, ENGINES, PUMPS, ROOFS, RETORT FITTINGS, ETC.



TELEGRAPHIC ADDRESS: ATLAS, BIRMINGHAM.

WELDED & RIVETED PIPES, FOUL MAINS, RETORT LIDS, WROT & CAST TANKS, PURIFIERS.

OVER 500 GASHOLDERS HAVE BEEN SUPPLIED AND ERECTED,

INCLUDING THOSE SUPPLIED TO THE FOLLOWING GAS COMPANIES AND CORPORATIONS:

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BELFAST.	BOMBAY.	BRISBANE.	HARTLEPOOL.	LIVERPOOL.	READING.	STOCKHOLM.
BECKTON.	BRADFORD.	CARDIFF.	LEEDS.	NOTTINGHAM.	RIO GRANDE.	SYDNEY.
BIRMINGHAM.	BRIGHTON.	COVENTRY.	LEICESTER.	OLDHAM.	SOUTH METRON.	VIENNA.

WEST'S GAS IMPROVEMENT Co., Ltd.,

(Mr. JOHN WEST, M.Inst.C.E., *Managing Director*),

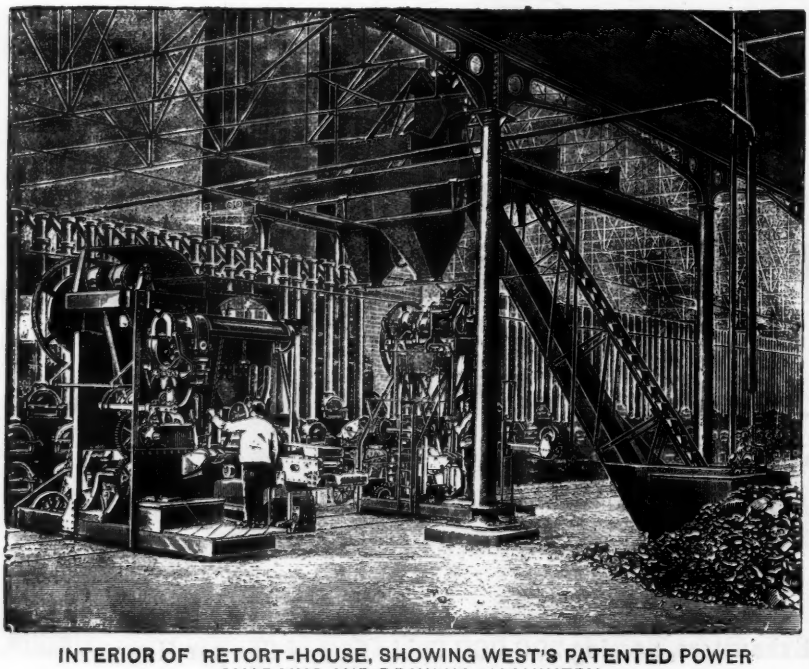
Engineers, Ironfounders, and Contractors,

ALBION IRON-WORKS, MILES PLATTING, MANCHESTER,

Manufacturers of

WEST'S PATENTED MACHINERY FOR CHARGING AND DRAWING GAS-RETORTS.

OVER **180** MACHINES AT WORK AND IN COURSE OF CONSTRUCTION.



INTERIOR OF RETORT-HOUSE, SHOWING WEST'S PATENTED POWER CHARGING AND DRAWING MACHINERY

MANUAL CHARGING AND DRAWING MACHINES.

POWER CHARGING AND DRAWING MACHINES.

COAL BREAKING, ELEVATING, AND CONVEYING MACHINERY.

COKE BREAKING, CONVEYING, AND WASHING MACHINERY.

OXIDE ELEVATING MACHINERY.

COKE BARROWS, VALVES, AND ALL GAS-WORKS PLANT.

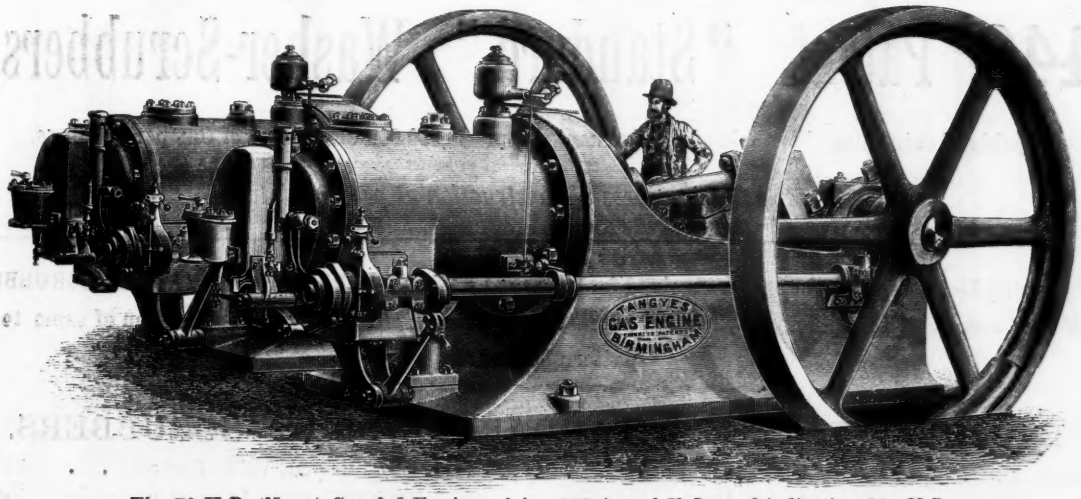
RETORT MOUTHPIECES
WITH SELF-SEALING LIDS,
FITTED WITH
KING'S
PATENT FASTENINGS.

N.B.—The whole of these Fittings are made of Wrought Iron.

TANGYES' GAS-ENGINE

"OTTO" PRINCIPLE. PINKNEY'S PATENTS.

Messrs. Tangye have laid down special Plant and Tools for the manufacture of these Engines, and are able by their system of MULTIPLE MANUFACTURE and of WORKING TO GAUGE to turn them out in the best possible style.



The 70-H.P. (Nom.) Coupled Engine, giving 172 Actual H.P., and indicating 200 H.P.

Single Engines from ¼ to 146 Actual H.P. (=170 Ind. H.P.) and Coupled Engines from 86 to 292 Actual H.P. (=340 Ind. H.P.

APPLY FOR ILLUSTRATED AND DESCRIPTIVE CATALOGUE OF GAS-ENGINES TO

TANGYES LIMITED, BIRMINGHAM.

ALSO AT

LONDON, NEWCASTLE, MANCHESTER, GLASGOW, SYDNEY, MELBOURNE, JOHANNESBURG, GENOA, BILBAO, and ROTTERDAM.

Telegrams: "TANGYES, BIRMINGHAM." No. 81 E.

MORRIS & CUTLER'S PATENT CONDENSER

IN USE AT OVER 70 WORKS.

NOW UNDER CONSTRUCTION FOR

COLCHESTER,
BELFAST,
BRAZIL,
HONG-KONG,
HARROGATE,
MANCHESTER.

CUTLER'S PATENT WATER-VALVES,

ESPECIALLY SUITABLE FOR PURIFIERS.

CUTLER'S PATENT GUIDE-FRAMING,

STRONG, SAFE, CHEAP.

EVERY REQUIREMENT FOR GAS-WORKS SUPPLIED.

16, GT. GEORGE ST., WESTMINSTER, S.W.

S. CUTLER & SONS,

PROVIDENCE WORKS, MILLWALL, LONDON.

KIRKHAM, HULETT, & CHANDLER, LIMITED.

[SIDNEY HERSEY, Managing Director.] [J. CHANDLER, Engineer.]

449 Patent "Standard" Washer-Scrubbers,

Capable of extracting the whole of the Ammonia from 426,560,000 Cubic Feet of Gas per 24 hours,

Erected and in course of construction at present date.

The following List comprises the orders received for Improved PATENT "STANDARD" WASHER-SCRUBBERS constructed according to the Company's latest patent, and Renewals effected by the application of same to old pattern Machines.

IMPROVED PATENT "STANDARD" WASHER-SCRUBBERS.

Birmingham	5,000,000	Kilmarnock	1,000,000	Lyons-Vaise (France)	525,000
Beckton	3,500,000	Dover	1,000,000	Barry and Cadoxton	500,000
,,	3,500,000	Colchester	1,000,000	Workington	500,000
Kensal Green	3,000,000	Cambridge	1,000,000	Lowestoft	500,000
,,	3,000,000	West Bromwich	1,000,000	Newton-le-Willows	500,000
Liverpool	3,000,000	Luton	1,000,000	Manchester	400,000
,,	3,000,000	Alger (Algieria)	875,000	Erfurt (Germany)	400,000
Croydon	3,000,000	Valencia (Spain)	875,000	St. Chamond (France)	350,000
West Ham	3,000,000	Barcelona (Spain)	875,000	Santander (Spain)	350,000
Rochdale	3,000,000	Nice (France)	875,000	Atlas Steel Works, Sheffield	250,000
Paris	3,000,000	Stockport	800,000	Bangor	250,000
,,	3,000,000	Magdeburg (Germany)	750,000	Lille (France)	250,000
Glasgow	2,500,000	Altoona (U.S.A.)	750,000	Melun ,,	210,000
,,	2,500,000	Smethwick	750,000	Valencia (Spain)	200,000
Manchester	2,500,000	Schneider-Creusot Works		,, ,,	200,000
Leicester	2,250,000	(France)	735,000	Vercelli (Italy)	200,000
Swansea	2,000,000	Valparaiso (Chili)	600,000	Rawmarsh	200,000
Bordeaux	2,000,000	Halle (Germany)	600,000	Baccarat (France)	175,000
Melbourne	1,500,000	Elberfeld ,,	600,000	Hitchin	150,000
Charlottenburg (Germany)	1,500,000	,, ,,	600,000	Sydney	100,000
Derby	1,500,000	Nancy (France)	525,000	Balson-Chateauroux (France)	70,000
,,	1,000,000	,, ,,	525,000		

RENEWALS.

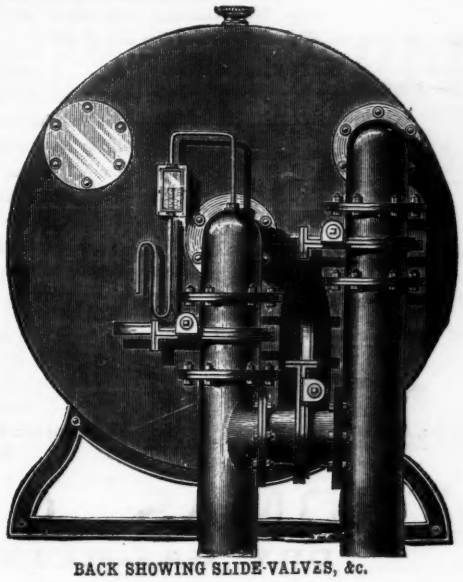
Birmingham	5,000,000	Hastings	1,500,000	Heckmondwike	500,000
Nine Elms (in part)	3,000,000	West Ham	1,500,000	Hampton Wick	500,000
Vauxhall ,,	3,000,000	Nottingham	1,500,000	Kingston-on-Hull	400,000
Dublin	3,000,000	Melbourne	1,500,000	Weston-super-Mare (in part)	400,000
Shoreditch (in part)	2,500,000	,,	1,500,000	Enfield	300,000
Beckton	2,500,000	Crewe (L. & N.W.R. Co.)	1,250,000	Harrow	250,000
Manchester	2,500,000	Beckton	1,250,000	Buxton	250,000
Bromley	2,000,000	,, (in part)	1,250,000	Quebec, Canada (in part)	250,000
Pimlico (in part)	2,000,000	Bradford	1,250,000	Newmarket	150,000
Plymouth	2,000,000	Maidstone	1,000,000	Leominster	150,000
Croydon	1,500,000	Smethwick	750,000	Kidsgrove	100,000
Edinburgh	1,500,000	Heywood	600,000		

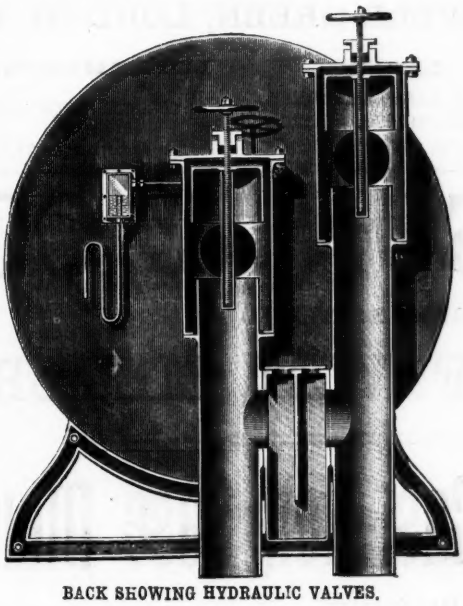
All New Patent "Standard" Washer-Scrubbers are fitted with the Company's Patent Improved Wooden "Bundles" or Washing Devices, which can be readily fitted to old pattern Machines.

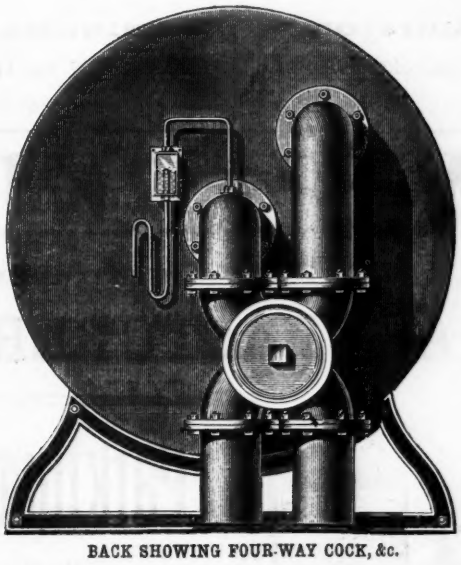
Address: 3 & 4, Palace Chambers, Bridge St., Westminster, London, S.W.

STATION & LARGE CONSUMERS' METERS
WITH ROUND CASES.

FRONT VIEW.


BACK SHOWING SLIDE-VALVES, &c.


BACK SHOWING HYDRAULIC VALVES.


BACK SHOWING FOUR-WAY COCK, &c.

The measuring capacity of a meter depends on the quantity the drum passes in **one revolution,** and not on the quantity the meter may be represented as "capable of passing **per hour.**"

The volume passed at **one revolution** indicates that the drum is of that capacity; but when this test of size is ignored, and only the quantity **per hour** is stated, a delusive standard is set up, which varies with every change in the pressure. Hence, when selecting Station or Large Consumers' Meters, the **capacity per revolution** should be the **only** guide in considering the size of the meter in relation to the price.

WE ALWAYS STATE THE CAPACITY PER REVOLUTION.

W. & B. COWAN,
ESTABLISHED 1827

SMITH SQUARE WORKS, WESTMINSTER, **LONDON, S.W.** TELEPHONE No. 3250. "DISC LONDON."

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BUCCLEUCH STREET WORKS, **EDINBURGH.** TELEPHONE No. 783. "DISC EDINBURGH."

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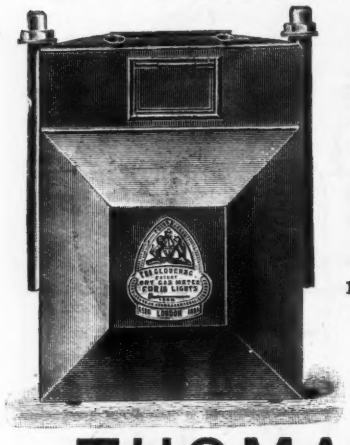
[ESTABLISHED 1844.] **ORIGINAL MAKERS.** [ESTABLISHED 1844.]

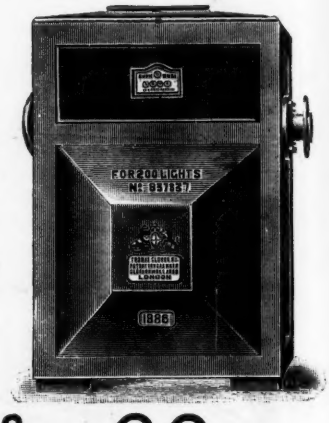
LONDON, 1851. NEW YORK, 1853. PARIS, 1855. LONDON, 1862. DUBLIN, 1865. PARIS, 1867.

THE SIX MEDALS AWARDED TO THOMAS GLOVER'S PATENT DRY GAS-METERS;
The latter being the Highest Award for Dry Gas-Meters at the Paris Exhibition, 1867. Since then we have not Exhibited FOR PRIZES.



1st.—Are a remedy for all the defects of Wet Meters.
2nd.—Are suitable for all Climates, whether hot or cold.
3rd.—Incur no loss of Gas by Evaporation.
4th.—Cannot become fixed by Frost, however severe.
5th.—Are the most accurate and unvarying measurers of Gas.
6th.—Prevent jumping or unexpected extinction of the Lights.
7th.—May be fixed either above or below the level of the Lights.
8th.—Cannot be tampered with without visibly damaging the outer case.
9th.—Will last much longer than Wet Meters.
10th.—Will not cost more than one-half for repair that Wet or Water Meters do.

Are upheld for five years without charge.



Telegraphic Address: "GOTHIC LONDON."
Telephone No. 6725.

THOMAS GLOVER & CO.,

DRY GAS-METER MANUFACTURERS,

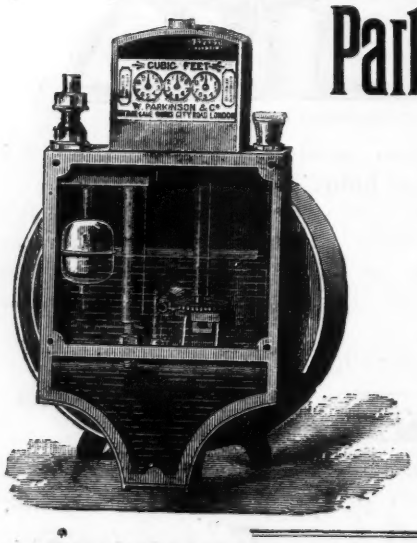
214 to 222, ST. JOHN ST., CLERKENWELL GREEN, LONDON, E.C.

BRISTOL:	BIRMINGHAM:	LEEDS:	MANCHESTER:
62, VICTORIA STREET.	3, BRIDGE ROW, DERITEND.	BOAR LANE CHAMBERS, 4, BASINGHALL STREET.	37, BLACKFRIARS STREET.
Telegraphic Address: "GOTHIC."	*Telegraphic Address*: "GOTHIC."	*Telegraphic Address*: "GOTHIC."	*Telegraphic Address*: "GOTHIC.

W. PARKINSON & CO.

ESTABLISHED 1816.

MANUFACTURERS OF WET METERS.



Parkinson's Cast-Iron Case Meter.

Works with very little friction.
Will stand very high pressures.
Cannot possibly be shut off by sudden increase of pressure; the float being affected by outlet gas only.
Allows for loss of water by evaporation without materially affecting the registration or shutting off the gas.
Unexcelled for Simplicity of Construction, Excellence of Workmanship, and Accuracy of Registration.

COMPENSATING METERS,

In Tinned or Cast-Iron Cases.

COTTAGE LANE WORKS, CITY ROAD,	BELL BARN ROAD WORKS,	OFFICE: 10, MAWSON'S CHAMBERS, DEANSGATE,
LONDON.	**BIRMINGHAM.**	**MANCHESTER.**
Telegraphic Address: "INDEX."	Telegraphic Address: "GAS-METERS."	Telegraphic Address: "PRECISION."

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THE

JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, JUNE 28, 1892.

Gas in the New Parliament.

LAST week we commented upon the position in which the Eight-Hour Day men will find themselves in regard to the General Election. We return to the same engrossing topic now for the purpose of drawing attention to the possibility that the result of the election may be to bring the compulsory extinction of the Metropolitan Gas Companies, and perhaps others with them, "within the range "of practical politics." So far as can be gathered from the addresses of many candidates for Metropolitan constituencies, the growth of the "Progressive" spirit in modern municipalities has impressed politicians of all shades; and if there should be time, in the period of the existence of the next Parliament, for the extension of municipal responsibilities to embrace many matters now left to private enterprise, there will not be any party of whom it can be said that they are pledged to resist this variety of State Socialism. The acquisition of the gas undertakings of London by the County Council was once regarded as a point in the Progressionist Charter only; but now there is little or no resistance to the suggestion from any quarter. It is treated as essentially a question of expediency. There is nothing to complain of in this development of public opinion; for when the subject comes to be inquired into, it will be upon grounds of expediency, and on these alone, that the result will be based. And what applies to the Metropolis will do so with equal force to all parts of the country. The next Parliament, if it lives long enough, will almost certainly register some further advances in the direction of the decentralization of domestic government; and from these alterations, whatever they may be, the arrangements for gas supply will hardly be excluded. Meanwhile, it is interesting to notice that the gas interest will not be better represented, numerically, in the new Parliament than in the old; and it may easily be worse off in this respect. Colonel Makins, M.P., the Governor of The Gaslight and Coke Company, does not intend to seek re-election. Mr. William Woodall, M.P., has a personal and family connection with the gas interest, and will probably be returned again for his old constituency, Hanley, although this time he is to be opposed. A very well-known and popular Gas Engineer and Manager (retired), Mr. D. Ford Goddard, lately Mayor of Ipswich, stands for that city; and the hopes of all his old colleagues of the profession, irrespective of party, will be with him in his effort to enter Parliament. Mr. John Aird's name is familiar in many circles besides that to which these lines are addressed. His seat should not be in serious danger. Sir Julian Goldsmid, Bart., the Chairman of the Imperial Continental Gas Association, is again offering himself to the electors of South St. Pancras; and he is being powerfully supported. We believe we have now named the principal representatives of the gas industry who are actually engaged in wooing constituencies with a view to sitting in the new House of Commons in the novel or customary capacity of Elect of the People. The list is short, but uncommonly select. Bearing in mind the importance of the gas industry of the United Kingdom, however, it may be surprising to some that it is not more largely represented in Parliament. It is a craze of the day that no order, class, or section of the community is safe in the enjoyment of its rights and privileges unless it is able to send to the House of Commons a sworn band of delegates, who, whatever else they do, shall be under orders to defend the cause for which they sit. Well, it has never been suggested that the gas interest, on the whole, has been hardly treated by the Imperial Legislature; but it is true that, considering its financial and industrial importance, this interest has been poorly represented in the Lower House. There is more in this reflection than meets the eye; but it is not for us to draw the inference.

A Question of Accuracy.

SOME notice should be taken of the remarkable figures relating to the illuminating power of Salford Corporation gas, which (as will be seen from an abstract report in another column) Mr. George E. Davis recently laid before the Manchester Section of the Society of Chemical Industry. The paper dealt generally with the testing of the illuminating power of coal gas, and related the author's experience of standards of light and photometers. This part of the paper was interesting. The author "slew the "slain" in denouncing the parliamentary standard candle as a standard of light for photometrical work. He called it the "boasted" parliamentary standard; but it would have been more to the purpose if he had admitted, what he must know perfectly well, that the term "abused" would have been more accurate. Mr. Davis also spoke with a spirit which is more that of a partisan than a man of science in his further references to the standard candle as

something that "might suit gas engineers, but not a "chemist with any idea of accuracy." Pray, who is Mr. Davis, and what are chemists as a class, that he, for himself or for them, should so presume to habits of "accuracy"? As we have already shown, Mr. Davis commits a glaring breach of this estimable quality in any man, whether he be chemist or controversialist, in misdescribing the current reputation of the standard candle. He knows that there is actually sitting at the present time a Board of Trade Committee, whose duty it is to find an acceptable substitute for the parliamentary standard of light; and we have yet to learn that it is to the scrupulosity of chemists, as such, that the origination of this movement should be ascribed. It is plain fact that the candles do *not* suit gas engineers; and it is to the productions of gas engineers that chemists like Mr. Davis have to take when they want something better. All this indication of the existence in Mr. Davis's paper of a lack of accuracy of description which, in such a stickler for exactitude as the author, is a deplorable proof of the frailty of human nature, does not predispose one to accept his returns of the illuminating power of Salford gas as incontestable. We do not know why Mr. Davis took all this trouble with Salford gas. At any rate, granting that every gas consumer has an indefeasible right to examine, personally or by a skilled deputy, the gas with which he is supplied, and that this particular consumer chose to exercise his right in the manner and with the results recorded in Mr. Davis's paper, what is to be said about it? Although the cloven foot of the partisan unquestionably peeps out from under the habit of the scientific observer which the writer of this paper put on before his public, we do not deny to Mr. Davis the regard due to his professional standing. No partisanship can be imagined of the necessary strength to make Salford gas indicate 12½ candles illuminating power if it left the gas-works 5 or 6 candles better. It appears to be a part of Mr. Davis's "brief" to prove that the testing of gas at the works is insufficient. Where the district of supply is large, this view is reasonable. But it may be remarked that Salford is not the only gas-consuming town in the kingdom; and that in London, as well as in some other places, the principle of testing gas at a distance from the works is regularly followed. There is nothing new, therefore, in this suggestion. It is perfectly certain, however, that there is no such difference between the quality of the London gas as made and as tested daily in various parts of the Metropolis, as Mr. Davis has found in the case of Salford. This is a matter for the particular consideration of the Salford Corporation Gas Committee. The circumstance that such statements as those of the paper should ever be published is indicative of the possibility that a gas supply may not be above suspicion, even when administered according to the tenets of an advanced Municipalism.

The Unit of Lighting.

An animated little controversy has been going on in the columns of our contemporary *Industries*, between the Editor and Mr. Trotter, whose recent paper on "Illumination" was discussed in the Journal, respecting the most convenient manner of expressing the intensity of lighting. The question is as to whether the amount of illumination received by a given surface (as the floor of a room, a writing or reading desk, &c.) is better stated as being equivalent to n candles at a distance of one foot, or to the light of one candle at n distance. As our contemporary puts it, "Mr. Trotter takes the illumination due to a "standard candle one foot away as unit illumination. "The unit of light (lighting?) is then taken as the light "falling on a square foot which is one foot away from "the candle. This leads to the curious result that a candle "gives a total light of 4π, or 12½ candles," which is perfectly correct if we remember that it is merely the conventional way of treating all problems arising out of the phenomena of radiation, whether of light or of any other of the undulatory forces. All the same, it is not without a shock that one is brought for the first time face to face with the assertion that there is mathematical reason in ascribing to one candle the potentiality of giving a total lighting effect of 12½ candles. It will be a mercy if the electricians do not get hold of this pleasing mathematical convention, and hoodwink unsuspecting local authorities with it. One can, indeed, hardly contemplate with equanimity the result of bringing such a magnificent specimen of the "unearned "(mathematical) increment" within arm's length of the Brush Company. The puzzle, of course, is merely one of definition. If the light received upon a surface one square foot in area at a distance of one foot from a candle is to be called lighting of one candle intensity, then every other square foot of the spherical surface at the same distance from the candle must also be held to receive one candle light; and since the surface of a sphere with radius unity is 4π, then the total lighting of the imaginary interior surface of a spherical shell of this dimension, which has a superficies of about 12½ square feet, must be 12½ candles!—*Q.E.D.* But the result is more than a little confusing to a practical mind, and therefore many engineers are in favour of doing without such a ticklish standard of illumination as one candle at one foot distance, or the "candle-foot," as Mr. Trotter calls it, and stating illumination in terms of the distance at which the standard candle would give the same lighting effect. This is the more natural method, because it seems reasonable to think of anyone, desiring a certain degree of lighting upon his work, moving a candle about until he gets it at the right distance. There is no quadratic computation about this method of settling the matter. If we tell a man that the light by which he is reading is equal to that of one candle at a distance of one foot from the page, he understands what is meant; and if he is of an inquiring turn of mind he can satisfy himself of the fact. So perhaps he could understand the "candle-foot," if the expression were never to vary from the unit value. When it came to fractions, however, he would readily follow the idea of placing the candle at any distance measured in feet and inches, or inches and tenths; but who can grasp at the meaning of a fraction of a candle-light? The question is worth a little more study than it has hitherto received from gas engineers, who, while they do most of the lighting in the world, leave the electricians to profess the monopoly of learning in the matter.

Gas at the Chicago Exhibition.

Commenting last week upon a certain passage in Mr. W. A. Valon's presidential address to the Incorporated Gas Institute, we ventured to intimate the existence of a doubt respecting the realization of the desires of the World's Fair Committee of the American Gaslight Association for a grand combined national gas industry exhibit at the Chicago Exhibition. Bearing out this statement comes a report published in the last number to hand of the *American Gaslight Journal*, which shows that up to the middle of June not half the amount of the guarantee fund estimated to be necessary for a respectable gas industry exhibit had been secured. The backwardness of the Gas Companies of the United States in supporting the World's Fair Committee is reviled by our contemporary in terms such as we commonly find employed in American newspapers with respect to those who are guilty of conduct with which the writers are not in sympathy. This, however, does not advance the matter. It is naturally a disappointment to members of the Committee and their friends to find that the largest and wealthiest Gas Companies of the country are not willing to support the movement which they have started; but it may be doubted whether the use of incoherent abuse in the public press will procure what has been denied to respectful importunity. Our enthusiastic, and somewhat hot-headed Transatlantic contemporary concludes its diatribe against the capitalists who do not yet see their way to subsidizing the World's Fair Committee with the suggestion that a time should be named for closing the subscription list, when the Committee should "go ahead with a building such as might "be completed out of the funds already pledged." The article winds up with the noble, if somewhat vague, declaration: "If we cannot have the cake of union, let us "consume the bread of independence." What would the Yankee newspaper writer be without his metaphors! It appears that the guarantee fund has reached at the present time a total of something like $60,000, or (say) £12,000. This would be a very respectable sum to be applied to the purpose of erecting an annexe to an English or a Continental exhibition; but, in view of the scale upon which the Chicago operations are being conducted, it is a mere trifle. Nobody knows to a million or so what the Chicago Exhibition will cost; but it is understood that by no conceivable fortune can it be preserved from realizing

a heavy loss. Everybody is going to lose money over it; and the electricians who have taken the contract for lighting the buildings and grounds are resigned, so they say, to sacrifice huge sums for the glory of the national celebration. Why, then, should the wealthy Gas Companies of New York, and even of Chicago itself, hesitate to make a similar sacrifice? Well, they do; and, as it seems to us, for very sound reasons. The World's Fair [Committee of the American gas industry have done their best to ascertain the disposition of the Gas Companies of the United States with regard to their project of action; and it is nobody's fault if the result is a negative one. It would be a pity if the Committee, carried away by their enthusiasm, were to embark upon a venture for which they have but poor means, and were so to exhibit to the world an unworthy result of half-hearted co-operation. A job such as they have taken in hand should be either well done or left alone. It will be no more a disgrace to the American gas industry to be excluded by the Executive from participation in the great show, than it is to the equally important national industry of petroleum, which is similarly treated. Our counsel to the World's Fair Committee, therefore, is to drop the matter without making any more noise about it, unless they receive better assurance than has yet been given that they will be supported by the whole strength of the industry which they desire to represent at Chicago.

An Unexpected Witness of Truth.

SOMETHING must have happened to the editorial staff of the *Workman's Times*. It is not at all a bad paper, as so-called "Labour" papers go. The management are perhaps too prone to rely upon padding out their serious matter with what are popularly known as selections of "American "humour," most of which have a sad, old flavour; and they do not dare to tell the working man when and how he has blundered under the leadership of Trade Union officials. They are virtuously trying, however, to persuade him to spend a penny a week for a paper that does not give sporting tips, nor purvey scandalous law news; and to this extent the editing is respectable. The reason why we presume that something has occurred at the head-quarters of the organ in question is simply the appearance in the current number of a rational statement respecting the wages paid to workmen in the United States, which goes counter, in the most uncompromising fashion, to the usual Trade Unionist fallacy that the measure of the happiness of the workman is the amount of the wages he receives. We say that this is a usual fallacy of the Unionist workman; but it would be possible, without sacrificing truthfulness, to go further, and call it a commonplace of Labour politics, as these have been understood by the ordinary run of British demagogues. "Money—more money—and yet more money!" is the cry of the agitator from mass-meeting platforms; and the chances are that when writers upon industrial matters who are not agitators, essay to compare the condition of the workman of one age with that of his predecessor or successor of another, it is the rate of wages paid which first engages their attention. This is quite natural and right; but error arises when the comparison stops there, and does not go on to inquire as to the purchasing power of the money received as wages at various times or in different countries. The Protectionist manufacturers' press of the United States incessantly tells the American workman that he is vastly better off than his brother in England; but here we find the *Workman's Times* deliberately telling its readers that, "bad as is the "condition of the British workman, we think that he is "much better off than his American brother, notwithstanding the fact that the American receives more "money in wages." The explanation of this is, of course, the high cost of living in America, due principally to the Tariff. The information upon whicht his statement is based is contained in a report of Consul Sadler upon the condition of the wage-earning classes in the Central and Western States of the Union. With reference to Chicago, Mr. Sadler states that a good deal of poverty exists there—poverty, too, which receives apparently very high wages. Thus, while a carpenter gets 54s. per week, which would be enough to enable him and his family to live with comfort in England, in Chicago he is just able to exist. And as with the carpenter, so with men of other trades. "They draw good wages; but they pay high prices for "the necessaries of life." Moreover, employment in the States is reported as being at the present time by no means regular. "When men get out of work, it is difficult "for them to get in again—more so than in this "country." Indeed, the only class of workers for wages who appear to "have the call" in America are domestic servants; all others are strongly advised to remain at home rather than trust themselves to the tender mercies of M'Kinleyism. These observations are to be pondered by those whom they most concern. And it must not be forgotten that, while the cost of emigration to the States is put very low by those who have an interest in the traffic, it is by no means so easy to get back again. The *Workman's Times* will deserve to succeed if it will only persevere in seeking out and publishing truths, whether or not these agree with conventional notions.

Society of Arts Medals.—The Council of the Society of Arts have awarded a silver medal to Professor Vivian B. Lewes, F.I.C., F.C.S., for his paper on the "Spontaneous Ignition of Coal and its Prevention," read during the past session.

The Managership of the Rugby Gas-Works.—Our readers will remember that, at the recent meeting of the Midland Association of Gas Managers at Rugby, Mr. Peter Simpson, the Engineer and Manager of the Rugby Gas Company, announced his intention of retiring. We learn that, in response to the invitation of the Directors for applications from candidates for the position, which appeared in our advertisement columns a few weeks ago, 75 were sent in; and that Mr. C. Meiklejohn, of Oldbury, has received the appointment.

The Late Mr. C. Nettleton, of New York.—The *American Gaslight Journal* of the 9th ult. contained a brief announcement of the death, in his 73rd year, of Mr. Charles Nettleton, of New York; and in a more recent issue some particulars are given of his work, furnished by his son, Mr. C. H. Nettleton, of Birmingham (Conn.). The early life of the deceased was passed on his father's farm at Washington, in Litchfield County (Conn.); but he took up the study of the law, and qualified himself for the legal profession. He established himself as an attorney in New York in 1851, and obtained a large practice, from which he retired two years ago. His active connection with the gas industry commenced with his purchase, in 1870, of the Mount Vernon (N.Y.) Gas-Works; and in the following year he was elected President of the East Chester Gas Company of Mount Vernon, and held the position till June, 1890, when the concern was purchased by the American Gas Company. In 1871 he became interested in the erection of the gas-works at Derby (Conn.), which were established for the supply of that town and the adjoining manufacturing villages of Ansonia, Birmingham, and Shelton; and the concern is now under the control of the deceased's only surviving son. The late Mr. Nettleton was, however, most widely known among the members of the gas industry of America from his connection with the American Gaslight Association, of which he was Secretary from 1873 to 1879; the office of Treasurer being combined in 1875. For several years he undertook the representation of the JOURNAL in America.

Society of Engineers.—Last Tuesday afternoon, a party composed chiefly of members of this Society, accompanied by the President (Mr. J. W. Wilson, jun.), paid a visit to the East Greenwich station of the South Metropolitan Gas Company and to the Tower Bridge works; a special steamboat being chartered for the purpose. The visitors were received at the jetty by Mr. J. Tysoe, the Resident Engineer; the Chief Engineer (Mr. Frank Livesey) and the Chairman of the Company (Mr. George Livesey) being unavoidably absent. Luncheon was served in the lower deck of the jetty; and at its conclusion, opportunity was taken to thank the above-named gentlemen, and also Mr. C. C. Carpenter, Manager of the Company's Vauxhall station, for their courtesy towards the Society in facilitating the arrangements for the visit. The inspection of the works commenced with the coal-hoisting machinery on the jetty. From the viaduct by which the coal-waggons are run into the retort-houses, the visitors had a view of the general plan of the works; the carbonizing portion being to the left, and the purifying plant on the right—the big gasholders rising in the distance. Descending to the ground level, the exhauster-houses were inspected; and then the visitors passed through the retort-houses, where West's wire-rope machinery and Foulis's hydraulic retort-drawer were shown. Crossing the vacant land, the new six-lift gasholder in course of construction—a description of which appeared in the JOURNAL for the 17th ult., p. 911—was reached; and, as on the occasion of the recent visit of the Incorporated Institution of Gas Engineers, it was the great feature of interest. Most of the visitors went down into the tank, the construction of which was fully explained. The washing and purifying arrangements were then inspected; and the visit closed. On the return journey a call was made at the Tower Bridge works, over which the party were courteously shown by Mr. E. W. Cruttwell, the Resident Engineer, and Mr. J. E. Tuit, representing Sir W. Arrol and Co., the contractors for the bridge. Westminster was reached soon after seven; the programme prepared by the Secretary of the Society (Mr. G. A. Pryce-Cuxson) having been excellently carried out.

WATER AND SANITARY AFFAIRS.

The ferment of political excitement may probably account for the neglect of the Daily Press to notice the two sittings held by the Metropolitan Water Supply Commission at the commencement of last week. The evidence of Dr. Frankland on Tuesday was particularly important. Had it been of a sensational character, directly condemnatory of the existing water supply, very probably it would have been paraded in the columns of some of the papers, and made the basis of editorial articles hostile to the Water Companies. Dr. Frankland has ever been an earnest adherent of the purist school; and, in years gone by, he has expressed views by no means of an encouraging nature in reference to the water supply of London. One of the most striking features in the evidence given by this long-practised authority last week was that, at the time of the Rivers Pollution Commission, the efficiency of sand filtration of water was under-rated. Asked whether, if the facts had been better understood, the report of the Royal Commission in 1874 would have been quite so severe as it was, Dr. Frankland replied: "No, "I do not think it would." This was followed by a very candid acknowledgment which ought not to be overlooked. In our report of the proceedings, Dr. Frankland will be found saying: "The recent discoveries in connection with "filtration have very considerably modified my own "opinion, and I have no doubt that of others also, with "reference to the value of filtration and its security." One incident which apparently contributed to this change of opinion occurred recently, when Dr. Frankland found, on testing the water issuing from the filter-beds of the various London Water Companies drawing from the Thames and the Lea, that, instead of getting hundreds of microbes per cubic centimetre, he obtained in some cases only four, and the maximum was only twenty-four. Dr. Frankland confessed that he was "somewhat astonished" at the result. This distinguished chemist clearly acknowledges that he is a learner in respect to phenomena concerning which there has been a large amount of mistaken dogmatism in the past. He now states that he is engaged in a series of observations which, he hopes, will throw "more "light upon the subject;" the point at issue being as to the probability of pathogenic germs existing in the water delivered in London. This question we are told is one which "still requires a good deal of investigation." The effect of a running stream on the lifetime of the organisms has long been a matter of dispute; and Dr. Frankland now says that in a flowing river, where the environment is never constant, the conditions "would be very fatal to the "life of the organisms." But again we are told: "The "amount of knowledge on the subject is very contradictory, "and very incomplete; and people are only just begin-"ning to know something definite about these organisms." One thing is certain, that Dr. Frankland's evidence on the subject would have been very different twenty years ago, independently of the fact that the water supply has been greatly improved in quality during that period.

Dr. Frankland is still apprehensive with regard to germs, be they few or many, and has a dread of their multiplying power. But there is reason to believe that the harmless germs are very largely in the majority, and help to kill the bad ones. There is a striking statement by Dr. Frankland, where he says: "I find that water, which "contained a large number of microbe organisms when it "came out of the river, would be almost sterile in the "course of a week or ten days." This bears on the question of storeage. In common with other witnesses, Dr. Frankland was pressed as to whether the supply taken from the Thames and the Lea was really a "safe" supply. Of course, it was too much to expect that Dr. Frankland would reply absolutely in the affirmative. Here, we think, a distinction should be drawn between the theoretical and the practical. Theoretically it is not safe to cross Cheapside when the street raffic is at its greatest height. But practically the venture is safe enough. Dr. Ogle used an argument of this kind, when showing that, if every fatal case of typhoid fever in the Lea Valley was a source of pollution, the germs would have to encounter in each instance "a body of water three miles long, two "miles wide, and six feet deep." This would also have to be coupled with the fact that 98 per cent. of the bacteria would be removed by filtration. Dr. Ogle asked whether, under such circumstances, the risk of infection would not be so much diminished that it might be "practically" disregarded? Dr. Frankland hesitated; but it was clearly on theoretical grounds.

While the microbes are at vanishing point, there is a further consideration. If the river supply is defective, and if it is thought worth while to abandon it at a certain cost, it does not follow that London has need to draw a supply from some remote source. Dr. Frankland errs somewhat when he says that deep wells in the chalk and the oolite contain no organisms. The microbes are everywhere; and we have no doubt they exist in the Elan and the Claerwen, as they do in the deep wells of the Kent Company. But no one will fear infection from such a source; and there is every reason to believe that, if the Thames and the Lea were abandoned, an abundant and unexceptionable supply would be found in the watershed of these rivers. With regard to this matter, Dr. Frankland is not called upon to cancel anything in the report of the Rivers Pollution Commission. He now expresses his belief that "for the next hundred years" there would be no need to go outside the Thames basin for a good supply of water. The mode of obtaining this supply was explained by Dr. Frankland in his evidence, and it coincides with the full account in the report of 1874. Associated with this subject, we have the manifesto of the County Council, requiring a supply of 35 gallons per head per day, to be provided for a population estimated to amount to at least 12,500,000 fifty years hence. The reckoning is speculative in the extreme; and several members of the Council have been sensible enough to demur to such a calculation. Alderman Beachcroft could only understand it as an attempt to cry down the shares of the Water Companies, and characterized it as "an alarming statement" to put before the public. Yet the document containing this extravagant statement has just been adopted for presentation to the Royal Commissioners, as affording "some "indication of the views of the London County Council "on the subject of the inquiry." The Commissioners will doubtless know how to value it. With respect to the part played by Sir William Harcourt in the defeat of Lord Cross's scheme for the purchase of the Metropolitan water-works in 1880, a letter from Mr. A. J. Balfour in *The Times* of yesterday fully confirms our previous remarks on the subject.

The Wanzer and Defries Lamp Company.—A private meeting of the proprietors of the Wanzer and Defries Patent Safety Lamp Manufacturing Company, Limited, was held last Friday, to pass a resolution to wind up the Company. As the proceedings were conducted with closed doors, the result was not made known; but on the following day a compulsory winding-up order was made by the Court.

Electric Lighting Scheme for Islington.—At a recent meeting of the Islington Vestry, the Special Electric Lighting Committee presented a recommendation that a Provisional Order authorizing the Vestry to supply electricity in the parish should be applied for. The Committee arrived at this decision after exhaustive research, and on the advice of an eminent engineer; and they came to the conclusion that it would be possible to give the supply at 5d. per unit, as against 6d. in St. Pancras and 8d. as mentioned by other promoters.

A New Form of Gas Battery.—The remarkable way in which one branch of physical research leads to another is illustrated by the statement that has recently been made that Mr. Ludwig Mond has found a means of utilizing his discovery of the chemically active character of carbonic oxide by making nickel and cobalt separate this gas from the hydrogen with which it is mixed in the ordinary production of water gas. When the separated hydrogen is applied to strips of platinum, as in Grove's classical experiment, a powerful gas battery is constituted, which returns in the form of electricity, as is reported, 50 per cent of the total energy of the absorbed hydrogen. If the same gas were burnt under a boiler for raising steam, and the steam so made used in a first-class engine driving a good modern dynamo, the yield of electricity would not exceed 8 per cent. of the fuel-energy of the gas consumed, under the most favourable conditions. It thus appears that Mr. Mond has advanced another step in the way of economizing energy, not by improving the steam-engine, but by going round it. Bearing in mind the admitted superiority, from the economical point of view, of the steam-driven dynamo to any form of galvanic battery yet devised, it would be a strange turning of the tables if it were to be demonstrated, as a practical result of Mr. Mond's discovery, that the gas primary battery and the water-gas producer together form a more economical apparatus for getting out the heat-value of fuel into some useful form, than any arrangement which has a combustion process for its starting-point.

THE INCORPORATED GAS INSTITUTE.

PROCEEDINGS AT THE TWENTY-NINTH ANNUAL GENERAL MEETING,

HELD AT THE

INSTITUTION OF CIVIL ENGINEERS, JUNE 14, 15, & 16, 1892.

Mr. W. A. VALON, Assoc.M.Inst.C.E., President.

DISCUSSIONS ON THE PAPERS.

In the JOURNAL last week we gave the papers read at the above meeting by Mr. F. G. Dexter, Professor Foster, and Mr. T. Newbigging. Those of Mr. W. R. Chester and Professor Lewes will be found in another part of the present issue; the communications of Mr. A. T. Walmisley and Mr. W. Gadd being held over till next week. We give below the discussions on the three papers which have already appeared.

MR. DEXTER'S PAPER ON THE USE OF STEAM IN THE REVIVIFICATION OF OXIDE OF IRON *in Situ*.

Mr. N. H. HUMPHRYS (Salisbury) said he was considerably interested in the paper, because there was much in it with which he agreed. They all knew the importance of having the materials in the purifiers properly moistened; and he might say that he was still continuing the mode of operation he described some three or four years ago. With regard to the over-heating of the material, and the consequent driving off of the moisture, there were two things concerned—one was the sizes of the boxes used, and the other the quantity of sulphuretted hydrogen dealt with. In this question of revivification, the chief thing overlooked was the question of the relative percentage of impurity which had to be removed. Some might have 0·5 per cent. of sulphuretted hydrogen to remove, and might have fairly large boxes to do it in; while others might have 1 per cent. to remove, and have smaller boxes, and would, therefore, be trying to do the same unit of work in one-fourth of the space, which, of course, had an important effect on the heating of the material. His experience had been rather favourable in this respect. At Salisbury they had large purifiers, and a comparatively small percentage of sulphuretted hydrogen to remove. The result was that the extent of heating was not large; and consequently the amount of moisture he had since he used air was very slightly different from what he had before. In talking about extracting moisture, it should be remembered that, in any combination of oxide of iron with sulphur, one molecule of moisture was liberated, and was absorbed again in the revivification; so that the process remedied itself in that respect. Altogether, he quite agreed with Mr. Dexter that, if means were devised to prevent the moisture from being exhausted or reduced too low, the greatest benefit would result. In his case, the moisture did not leave at so rapid a rate; but there was plenty left at the conclusion of the process, when the oxide became spent. It swelled and caked not so much on account of the extraction of moisture, as from the accumulation of sulphur. These experiments, showing that by the use of steam there was a large increase in the duty obtained from oxide, were extremely interesting; and they seemed to show the importance of further experiments in the same direction. But he had no experience of his own on this point.

Mr. G. ANDERSON (London) said he thought Mr. Dexter was on the right track. Some forty years or so ago, when managing his first gas-works under the late Mr. Croll, he made him put the waste steam from the high-pressure engine which worked the exhauster into the condenser (which was a horizontal one) round the retort-house. It was not put in for the purpose Mr. Dexter now indicated; but they found that the gas was considerably purified from sulphuretted hydrogen in going through the condenser, because most of the water from the steam was recovered at a drip, and it was nearly as black as ink. The purifiers had their connections about 3 inches above the bottom, and they were always filled with water as high as these; so that there was moisture throughout the whole purifier. If gas were passed through dry lime or dry oxide, it would not be purified. He was much interested in the remarks as to the effect of driving air through the purifiers. The oxide was purified above instead of below, which would be contrary to one's first expectation. Doubtless this was due to the top being more moist than the bottom, on account of the air having driven the moisture forward. All these things went to show how necessary it was to rigidly investigate these little instances. By having the material in a proper condition, one might double the length of time a purifying-box would last. He could state as a fact that he had hardly ever gone to a gas-works where they were purifying with lime and had not found it being put in too dry. He supposed the reason was that, in old books on gas manufacture, they were told to wet the lime until, if a handful were taken up, it would just hold together; and he presumed a great many men worked on this rule. He believed strongly in moisture; and he always advised his men to make the lime as wet as they could, provided it did not run into mortar. He had often been told that by so doing they doubled the time the purifier would last.

Mr. W. R. CHESTER (Nottingham) said he noticed that Mr. Anderson did not say he would recommend the use of steam now. The addition of steam in the condenser seemed to him (Mr. Chester) a very contradictory way of working, inasmuch as the object of the condenser was to cool the gas, whereas the steam would warm it up again; and, in addition to that, it must have a very detrimental effect, from an economical point of view, in abstracting and wasting a large quantity of ammonia which, in the ordinary mode of purification, would be recovered. He had carefully gone through the paper, and he noticed the absence of certain statistics which would enable one to form an opinion as to how far the presence of moisture was beneficial or otherwise. Mr. Dexter did not give the area of the purifiers, the quantity of gas purified per ton of oxide used, or anything as to the point to which it was desirable to reduce the moisture in the oxide, in order to obtain the greatest efficiency in purification. His own experience was that where they commenced to use oxide highly charged with moisture—say, 50 per cent.—they obtained a very small efficiency, and that the efficiency increased as the moisture was reduced—the highest point being reached when the oxide contained about 4 per cent. of moisture. He had not had any experience in the use of either air or oxygen for the purpose of revivification; believing that a large area of purifiers would give a much more satisfactory and economical result than could be obtained by such artificial means as the addition of air or oxygen for the purpose of revivification *in situ*. It seemed to him that it was merely a question of degree as to the area of the purifiers in proportion to the make of gas, and the percentage of moisture necessary to render the oxide practically workable. If they had a small area of purifier, and the moisture of the oxide was down to about 10 per cent., this was probably about the extreme limit at which they could work; but as the area was increased, the percentage of moisture could be reduced to something lower, and the efficiency of the oxide itself be thereby greatly enhanced.

Mr. W. HARDIE, jun. (Tynemouth), said that it seemed to him to be a most extraordinary thing that there should be so much better results in the winter than in the summer, as, in his experience up to the present time, he found their cost for purification per 1000 cubic feet in the summer was about half what it was in the winter. A short time ago he doubled his purifying power by passing the gas through two sets of four purifiers each, instead of only one set, and he found the cost was reduced exactly one-half. Therefore he could not understand the reason for the result obtained in this particular case being so much better in the winter. Again, the details in the paper did not seem to be quite sufficient. Mr. Dexter had given the number of cubic feet of gas per box changed at 3 million cubic feet; but this afforded no idea whatever of the work that was being done. In his own case, he had passed perhaps ten times this quantity of gas through purifiers without changing them. It all depended on the size of the purifiers.

The PRESIDENT said the paper was a very interesting one; and the subject deserved more attention than it had received. He should say also that the paper was produced at very short notice, and that Mr. Dexter had not had time to give so much statistical information as he would have liked. At the next meeting he would, no doubt, be prepared to complete what was in reality a very interesting communication. Mr. Chester had referred to the

economy of using air or oxygen with oxide of iron; but he (the President) presumed he did not extend this remark to lime. If he did, he could not agree with him. He thought Mr. Hardie must have misunderstood what was said about summer and winter. If he looked at Nos. 1, 2, 3, and 4,* he would see that this was so.

Mr. HARDIE said he saw he had made a mistake; but what led him into it was the passage lower down about the greatest increase of efficiency being obtained in winter. He found his purifiers worked much more effectually in the summer.

Mr. DEXTER, in reply, said it would perhaps have increased the value of the paper if he had added what statistical information he had already obtained. But it was not by any means complete; and he should prefer to give all the particulars together. Mr. Humphrys agreed with him that the question of moisture was of great importance; and he inquired as to the size of the boxes he used. They measured 24 ft. by 12 ft. There were two layers of oxide, from 1 foot to 15 inches deep; the amount in each box being roughly 15 tons. The quantity of sulphuretted hydrogen dealt with necessarily varied at different times of the year; but, taking the four analyses which had been made, he found the quantities ranged from 450 to 500 grains per 100 cubic feet. This was rather small, and showed they had not very much difficulty. The important point was this (and that was the reason he had put it in the form he had, of a comparison of working steam and air, as against air alone, under identical conditions), that the efficiency of the boxes, whether in summer or in winter, was doubled. Whatever percentage of sulphuretted hydrogen might have been present in the gas under one condition and time, winter or summer, would be equally there at the corresponding time in the second year, working under similar conditions. Therefore, for the present, he thought the fact was clearly indicated, that, by keeping the oxide thoroughly damped, a great increase of efficiency resulted. Mr. Humphrys referred to the fact that he did not experience much difficulty with the heating of the oxide, on account of the boxes being larger in area. He (Mr. Dexter) did not quite follow that, because it appeared to him that, whether the boxes were large or small, the heating effect would depend on the amount of chemical reaction going on in a given time. If it were a large box, and the oxide were as deep as in a smaller box half the size, there would be twice the quantity of material. But it was a common practice to have oxide of less depth where the boxes were of sufficient area; and one might have no more actual bulk of material in a larger box than in a smaller one. The chemical action going on would, if anything, be greater in large boxes than in smaller ones, because they gave better results, and therefore did more work; and the more work they did, the greater would be the heat produced. Mr. Humphrys also referred to the question of the water formed by the chemical reactions themselves, which was understood to be sufficient to supply the moisture the oxide required. This depended on whether the heating effect was sufficiently intense to drive off the moisture, or whether it allowed it to remain in the oxide. This was the turning-point of the whole thing. If the percentage of air admitted—and that depended on the condition of the oxide as well—were such that the chemical reaction going on was sufficient to drive away the moisture as it was formed, it necessarily followed that the oxide would become dry. He felt sure that some of the gentlemen present had experienced the fact that oxide treated with air came out of the boxes in a dry, hard state. The moisture had disappeared somewhere; and the chances were that it had gone out of the oxide and into the gas. By admitting moisture in the way he had described, that deficiency was made good, and the oxide was better enabled to carry on the revivification. Mr. Anderson had referred to the fact that it was bad to have the material too dry; and he also alluded to steam having been introduced into condensers many years ago. This was a similar practice to that of Mr. Cleland. Mr. Anderson had likewise mentioned the fact that moisture was found collected at the bottoms of the boxes; and he attributed to this their increased life, and the better result he obtained from the purifiers. Mr. Cleland's idea was to get rid of the whole of the water; but as (as in Mr. Chester's case) he was not using the air process, the heating effect referred to in the paper was not going on, or at any rate, not to anything like the same degree, as in the air or oxygen process. If the chemical re-action of revivification were carried out inside the boxes, it increased the heat; and this heat must do some work. It would to a certainty drive off the moisture. There was nothing else to go, unless the heat was sufficiently intense to set fire to the material. With regard to Mr. Chester's question as to the likelihood of the ammonia being lost, Mr. Cleland distinctly claimed an increased yield by the use of steam. He (Mr. Dexter) did not know where the ammonia was to go to if the lids were kept close, and the liquor not allowed to attain too high a temperature. But the distinction between this idea and the one with which he was dealing was this: In that case the steam was applied to get rid of the ammonia, as well as the sulphuretted hydrogen, as an impurity; and the whole of the moisture was removed before reaching the purifiers. In this case, however, the ammonia was taken out first; and it was clean gas, or gas with only a trace of ammonia, which went forward to the purifiers, *but in a humid state*. Very weak liquor was obtained from the condensing apparatus. He might mention that, before trying the effect of moisture, in the form of exhaust steam, in the oxide boxes, he tried passing exhaust steam into the scrubber. This was before the scrubbing plant was increased to its present capacity; and the yield of ammoniacal liquor was very nearly doubled. The steam did no harm there. If it was introduced and allowed to mix with the gas, as it condensed in a subsequent stage, it necessarily brought out the ammonia. The work of a scrubber or washer was essentially to so split up the particles of gas as to cause them to come into intimate contact with the water. Both the gas and the water had to be in a fine state of division. The gas was in that condition already; and if they had the water like it by being in the form of steam, a better mixture was necessarily obtained. With regard to the quantity of moisture required, it was quite out of the question to determine this at present. It would need a long series of experiments to determine it thoroughly; and he was not at present in a position to give the information, though he hoped to do so at some future time. Mr. Chester had also referred to the introduction of air as being an artificial means; but he (Mr. Dexter) could not agree with that. One might as well say that taking the oxide out of the box and exposing it to the air was artificial. It was exactly the thing they wanted to do; and if the life of a box could be prolonged, nuisance abated, and labour saved by passing in a small percentage of air—so small as not to interfere with the illuminating power of the gas—this was the important point. With the aid of steam, the quantity of air might be *decreased*. At any rate, it was certainly worth trying. In Winchester it was very important. Their purifiers were arranged some distance above the coal-shed, right in the middle of the town; and if there was the slightest smell, a great nuisance was created. Everything therefore, that could be done to prolong the life of these boxes should be carried out. Mr. Hardie had stated that he was unable to account for the increased work of the purifiers in the winter as compared with the summer. It was ordinarily understood to be more difficult to maintain the efficiency of purifiers in the colder than in the warmer weather. One of the chief advantages he claimed for the introduction of exhaust steam in the way he had described was that the hardening or caking process was stopped, and therefore the oxide gave better results. Keeping up the temperature of the material enabled more work to be done by the purifiers. If they became thoroughly cold, the oxide would not do anything like the work it would perform under similar conditions on a warm, humid day. The increase of efficiency was partly to be attributed to the fact that the temperature was raised, and the oxide was in a better condition to go on purifying the gas, or revivifying, as the case might be. He hoped to be in a position to give further particulars next year.

* See *ante*, p. 1173, col. 2.

PROFESSOR FOSTER'S PAPER ON THE LIGHTING VALUES OF ENGLISH COAL GAS.

Mr. W. CARR said he could not compliment Professor Foster on the clearness of his paper; but he thought this might be on account of the fact that he had been sequestered for some time in a heathen land, and had lost the habit of

following a scientific communication. However, as others seemed loth to commence the discussion on such an important paper, he was led to believe that the fault was with the writer in not having made himself understood. He did not comprehend such figures as 62 per cent. of carbonic acid in illuminating gas of 21-candle power, or those of 122 per cent. in the table; they rather confused him. He regretted this all the more because he took a great interest in the paper—the ground covered being perhaps of greater importance than anything to be submitted to the meeting. If half the attention had been devoted to this subject which had been given to the construction or decoration of gasholder columns, the cause of the gas industry would have been very much farther advanced than it was at the present time. They all seemed to be floundering about as to what constituted the illuminating properties of gas. Some people tried to determine it in one way, and some in another. Certain authorities framed rules by which they were to be guided; and if the gas did not fulfil these conditions, they said it could not be what it was supposed to be. For example, there was the specific gravity test, and also the bromine test; but they did not help to clear up the matter at all, but only to confuse it. When they tested gas in a photometer, they knew what illuminating power it had. But they were very far from knowing why it had this light-giving property; and any effort on the part of Professor Foster, or anyone else, which would at all help to remedy this want of knowledge, would be very useful to those who had to deal with the manufacture of illuminating gas. He hoped, in any further efforts made in this direction, Professor Foster would try to come down to the level of their understanding, and make the matter more plain. It used to be argued that any attempt to raise the production of gas from 9500 cubic feet per ton was simply throwing money away, because what was gained in quantity was lost in quality. He had heard eminent gas engineers make such statements as these with a great deal of confidence; but it was unnecessary to say that this idea was now thoroughly exploded. It was found that one could increase the production without lowering the illuminating power, and might even increase the illuminating power at the same time; but no one had been able to say exactly why it was so. It was simply want of knowledge which led him into many difficulties in discussing a paper of this kind. He remembered some years ago remarking to Professor Foster that he would like to know what the alteration in illuminating power would be if the heavy hydrocarbons were converted into acetylene and hydrogen. In his opinion, the illuminating power of the gas would be greatly increased, and yet the specific gravity would be less. But this point was, he understood, not yet determined; and there was evidently a large field in this direction that was thoroughly well worth working.

Mr. N. H. Humphrys (Salisbury) said the members were much indebted to Professor Foster for bringing forward these analyses. They could all, with great advantage, give more attention to the actual composition of the gas supplied, than it was their custom to bestow upon it. The analyses had been made on the plan adopted by Dr. Percy Frankland; and, like his, they presented some peculiarities. Dr. Frankland published in 1884 his analyses of some 20 or 30 samples of gas; and a strange feature about them, which he noticed in the Journal of Gas Lighting at the time, was the varying quantities of nitrogen. They ranged from 2·5 up to 10 per cent. with gases of about the same illuminating power; and, so far as one could judge from the other constituents, there was nothing to show any compensation for the quantity of nitrogen. In the anaylsis Professor Foster had placed before them, they had the same thing. For instance, take Nos. 1 and 3 in the first table [*ante*, p. 1174]. The heavy hydrocarbons in Sample No. 1 were 4·35 per cent.; and in Sample No. 3, 4·62 per cent. But one had to consider not only the proportion of these heavy hydrocarbons, but their quality, so to speak; and it had been said that one obtained a better idea of the relative value of the hydrocarbons if the percentage were multiplied by the carbon density, than by taking the percentage only. The carbon density in No. 1 was 3·2; and in No. 3, 2·53. By multiplying the 4·35 by 3·2, a larger quantity resulted than if the 4·62 were multiplied by 2·53. In No. 1, the proportion of nitrogen was 2·52 per cent.; and in No. 3, 7·1 per cent. Yet the illuminating power of the gas was half a candle better in the case of Sample No. 3. Again, take Nos. 5 and 6, the proportion of heavy hydrocarbons multiplied by the carbon density, came out about the same; but there was a difference of no less than 10 per cent. in the proportion of nitrogen. The difference in the illuminating value, however, was only about 0·6 of a candle. Going to the second table, and taking the quantity of nitrogen present, Professor Foster arrived at the result that the nitrogen lowered the specific lighting value of the carbon. But they had to look at the gas in the condition in which it was supplied and sold to the public, as represented in Table I.; and really from that table it seemed to him that the presence of nitrogen was an advantage. It was stated that in none of these analyses was air admitted for purification purposes, but that it must have been drawn into the retorts by the exhauster. No doubt this appliance was worked as hard as it could be, without lowering the illuminating power. In No. 4, again, the nitrogen went up to nearly 14 per cent.; yet there was an illuminating value of nearly 17 candles. Against this, however, there was no large proportion of heavy hydrocarbons, and no extra quality, as shown by the carbon density, to compensate. In discussing the subject of air purification, he ventured some three years ago to say that he did not object to the presence of 2½ per cent. of nitrogen in gas. It was thought then that even this was a great extent to go to; but here they found that only one of these analyses showed less than 2½ per cent. of nitrogen, and they went up to 7, 9, and even 13·89 per cent. According to the experience of a great many as to the deteriorating effect of 7 or 8 per cent. for each percentage of air, the Sample No. 4 ought to have practically no illuminating power at all; yet it held its head among the rest, and was better than some of its neighbours. He should be glad if Professor Foster could give some further information on this point, because it really seemed that the addition of 10 per cent. of nitrogen was the best plan to follow. It did not cost anything. They were all interested in working as cheaply as they could; and if they could add this 10 per cent. of nitrogen without reducing the illuminating power or the heating value of the gas, which was supposed to be somewhere proportionate to the quantity of oxygen required for its complete combustion and to the carbonic acid given off, it really seemed to be best to adopt this plan.

Mr. B. H. Thwaite (Liverpool) said there were two items in the table which he did not quite understand—viz. Nos. 5 and 6, in which the hydrocarbons were practically the same, and yet the actual illuminating value of the former was 18·5 candles, and of the latter 19·1 candles—a difference of 0·6 in favour of No. 6. He thought the results now given were of enormous value; and they practically corroborated some of his own experiments. He had been working on the enrichment of generator gas; and, according to the ordinary ideas, he introduced enough nitrogen to destroy the illuminating value altogether. But he might say that, with an ordinary generator gas, having 20 per cent. of nitrogen, he had been able to obtain an illuminating power of 20 candles. His results had thus been partially corroborated by Professor Foster's paper.

Mr. W. W. Hutchinson (Barnsley) hoped Professor Foster would add to the obligation under which he had placed the members by giving them his method of calculating the results in Table II. from the experiments recorded in Table I. He did not quite understand what value the author placed upon the hydrogen density given in the second table. He should also like to know particularly at what value Professor Foster rated the effect which the density as well as quantity of the heavy hydrocarbons had on the calculation.

Mr. C. S. Ellery (Bath) said he hoped Professor Foster would supplement the valuable results he had given by adding at some future time a few tests made with samples of gas manufactured where the air purification process was employed. It would be very interesting to compare the analyses of such gas with the gases now dealt with. He might be wrong in his way of reading the figures; but it appeared to him that there had been introduced into certain of these gases something over 2 per cent. of air. If this were so, it rather corroborated his contention that one could advantageously add a considerable percentage of air in the process of purification. If a sample of gas would be useful to Professor Foster, he should be pleased to supply him with it, in order that one might really see how it would compare with the figures before

them. It was evident they ought to make some allowance for cases where air was introduced; and the ultimate composition of the gas would probably be different, if the air were put into a heated retort, from what it would be if put into the gas at some subsequent part of the process—say, in the condensers, or in the hydraulic main. At any rate, he was strengthened in the position he had taken up, notwithstanding some remarks contained in the President's address, that a certain percentage of air might be used with considerable profit in gas purification. He (Mr. Ellery) did not quite understand how the illuminating power of the nitrogen-free gas had been arrived at. He could understand how the illuminating power could be estimated by taking the quantity of oxygen required for perfect combustion of the gas. With regard to the samples of Dinsmore gas referred to towards the close of the paper, assuming that No. 1 was 21·8-candle gas, and the percentage of carbonic acid produced 63·12, the proportion of the next sample should be, not 22·3, but 23·6 candles. He had divided 21·8 by 63·12, and multiplied by 68·44, which worked out to 23·6. The proportion did not run by the oxygen test, as it did with the photometer.

Professor FOSTER said the figures were published in 1889, and were the subject of much criticism; the President having had something to say on the matter of the specific gravity. He had never publicly answered these criticisms, because he was not in a position to produce satisfactory experimental evidence. However, the lighting values, as determined by the Sugg "G" Argand burner, were unquestionably as represented. He now showed that 100 volumes of these Dinsmore gases, exploded with an excess of oxygen, produced a given quantity of carbonic anhydride, and therefore they had so much carbon vapour in them. As Mr. Sugg had on one occasion said, no one had yet been able to make a large flame without using a considerable amount of carbon vapour. The man who could produce coal gas of high lighting value without putting carbon vapour into it had an invention. A sample of coal gas yielding on combustion 68 per cent. of carbonic anhydride was a rich gas, and would indicate about 21 candles when tested in the "London" Argand. They were also of very low specific gravity. One could scarcely call them ordinary coal gas; and therefore Mr. Ellery's computations, based on these samples produced by special processes, and tested by means of an Argand different in some particulars from the "London" Argand, were scarcely admissible.

Mr. ELLERY said he thought his point was not quite clear. If, exploding gas with oxygen, 63·12 per cent. of carbonic acid was produced, and the illuminating power corresponded to 21·8 candles, then the gas on the next line, producing 68·44 per cent. of carbonic acid, should be of 23·6-candle power, whereas, with a "G" Argand burner, it only showed 22·3 candles. One was evidently wrong—either the Argand burner or the method of calculation.

Professor FOSTER, replying to the discussion, said that he was in a rather awkward position. He was told that he nearly killed the Institute last year by giving a paper too far above the heads of the members; and for this he sincerely apologized. When he presented the substance of the present paper to another learned society, he was told that it was not sufficiently scientific, and too technical. So that he was neither scientific enough on the one hand, nor technical enough on the other. He really thought Mr. Carr's absence in South Africa had not kept him in touch with gas manufacture; and he was sorry to see he was not now so apt in discussing some of these questions, which he had so well dealt with before. The figures referred to were these: If one took 100 volumes of gas and exploded them in a eudiometer with excess of oxygen, a certain quantity of oxygen was required to complete the combustion; the carbonic anhydride produced being a measure of the lighting value. The latter was a function of the carbon vapour present in many forms in the gas. Whether it was proportional or not, was a matter under debate. There was no question about nitrogen being in these samples. It was doubted in the case of Dr. Percy Frankland's analyses; and one eminent engineer, having first expressed great doubt as to there being 10 per cent. of nitrogen in his gas, turned round and said: "What does it matter, so long as the public get their value?" But this was not the way in which he (Professor Foster) had approached the question in his paper. They were not at present concerned with the statutory obligations of any gas company. All the samples of gas referred to in his communication were of statutory quality. Each was determined at the time by a skilled operator, and confirmed by the speaker. In this respect the observations supplied information which was not given by Dr. Frankland, who knew nothing, from direct photometrical measurement, of the lighting values of the gases he analyzed. That three or four gas-works should be making gas containing these large quantities of nitrogen, purely by accident, and yet supplying gas of statutory quality, was certainly unexpected. It was the finding of certain figures, in connection with these matters which he could not understand, that led him to go more deeply into the question. The bromine test (Dr. Fyfe's) had been referred to; also Dr. Frankland's and Mr. Hartley's experiments with the heavy hydrocarbons. These were all attempts to determine the lighting value by means of such small volumes as 4·35 and 5·84 per cent., and so on. The variations in the heavy hydrocarbons were never great; and all these chemical tests had so far, he believed, disregarded the fact that one had marsh gas to the amount of 35 per cent., non-luminous in itself, but playing a very important part in all illuminating flames. Let anyone try to carburet a gas like hydrogen or air, and then try marsh gas, and he would find the difference. There was in the case of marsh gas a latent value in the carbon which made a remarkable difference. He did not exactly know the chemical changes which took place in consequence of the presence of marsh gas—probably no chemist did. He merely advanced views founded on his own experiments, in which account was taken of the presence of these quantities of 7 per cent. by volume of carbonic oxide, and 35 per cent. of marsh gas, which indirectly contributed very largely to the lighting value. He never had a fancy for determining the lighting value by bromine or fuming sulphuric acid, because of their vagueness; but he had found, as he thought, a very simple connection between the total volume of carbon vapour and lighting value. In fact, if any member would give him a sample of gas of which he had determined the illuminating power, he thought he should be able to predict, within a quarter or half a candle, what it would be by this method. He, of course, meant a legitimately-made coal gas, not a gasoline vapour put into nitrogen, carbonic anhydride, or anything of that sort, which, of course, would be disclosed on analysis. The specific gravity test, he believed, would be found entirely fallacious with reference to any gases other than legitimate coal gases made in a definite way. He could not say why a sample of coal gas should have a certain lighting value, and so he only reasoned from such data as he now brought before the Institute. To assert that one could put nitrogen into the gas without depreciating its lighting value was absurd. He only stated what he had found; and it was the extraordinary fact of these large percentages of nitrogen being there that led him to put these things together in this way. The richer the gas, the more carbonic anhydride was produced. He disregarded all the various forms of carbon vapour, and found that certain values were given; and then he estimated the nitrogen, calculating its effect as a diluent on the basis of Dr. Frankland's observations. He could quite understand that, diluting the gas with nitrogen beyond a certain amount would seriously lower the illuminating value; but, at any rate, that gentleman's experiments showed that, up to a certain point, well within his (Professor Foster's) own figures, the depreciation was proportionate to the amount of nitrogen. If, therefore, gas containing 90 per cent. of combustibles and 10 per cent. of nitrogen had a certain illuminating value, as 90: 100 so was the observed value to the value of the gas free from nitrogen. This was how Table No. II. was compiled, and how the diagram (see p. 1174) was drawn up on the basis of Table No. II. A curve was obtained which was very characteristic. In three cases, where little or no nitrogen was present, the points on the diagram representing percentages of carbonic acid, if joined, formed a straight line. In three out of the four cases where nitrogen was present, the percentages of carbonic acid were to the right of this straight line; showing a diminished lighting value for a given percentage of carbon vapour. This was an explanation of his statement that the lighting value of the carbon had been lowered by the admission of air. He was unable to prove that air had entered at the retort. If Frankland's observations were accepted, this was the only intelligible explanation at present

possible. However, he was quite sure that a knowledge of these three points—the carbonic anhydride produced, the amount of oxygen used, and the amount of nitrogen present—would give results far more in accordance with the actual facts, as determined by the photometer, than anything with which he was acquainted. Of course, the lighting value must always be determined by the photometer; but there were occasions when one would like to know what the composition of a gas was, and also its lighting value, so as to ascertain what was being done in the retort. He had no doubt that those works which were producing gas with a variable amount of nitrogen were not being all carried on at the same temperature. Increased temperature split up the paraffins into non-saturated bodies like olefines. Dr. Frankland had clearly shown that, if one took 5 cubic feet of a gas called ethylene (C_2H_4), a certain lighting value of (say) 70 candles was obtained when it was consumed in an Argand burner; but with 5 cubic feet of the paraffin C_3H_8 which would be found in rich gases, though its specific gravity was higher, its lighting value was only one-half that of the ethylene. This was a paradox; and it was an appreciation of these differences that enabled one to understand some of the very wide discrepancies which had recently been noticed between the illuminating value and the specific gravity of a gas.

The PRESIDENT said they thanked Professor Foster for his very valuable technical paper, which he confessed it would take him some time to study before he felt at all able to criticize it. He only wished to remark that he did not intend to convey, by anything he had said in his address, what Professor Foster now seemed to suggest. His experiments were not on "all fours" with those of the Professor, nor were they founded on any hypothesis whatever, but on facts. Professor Foster and he might have an opportunity of settling this point of specific gravity, and the difference between the values of constituents; but this was an entirely different matter.

MR. NEWBIGGING'S PAPER ON TANK CONSTRUCTION.

Mr. J. HEPWORTH (Carlisle) said he was not able to add much to the value of the paper. As it was being read, he could not help thinking that really there appeared (as, indeed, Mr. Newbigging said at the conclusion) to be no difficulties when he had to deal with them, for he always found some easy method of overcoming them. The difficulties which had been referred to, however, were very serious in the hands of a man without much experience, and such persons, at all events, should be very grateful for the paper. He had been much impressed with the observation with reference to the use of puddle; and he believed the explanation of the failure of a great many tanks was that the condition of the puddle had not been carefully watched. He had constructed several tanks, and was just trying to remember what difficulties he had met with. He recollected, in the case of a large concrete tank, when he thought he had overcome every difficulty, and provided for taking away the whole of the water from the springs (which were very considerable), just as it was nearly completed, some very unexpected springs showed themselves in the bottom of the cone; and the problem was how to deal with them at that time. Of course, he resorted to additional pumping, to keep down the extra pressure; but there was a difficulty in dealing with the small springs, which even pumping did not seem to overcome. At the very last, when the tank was about to be filled with water, they had recourse to some preparation of red lead and fine cement, and insisted upon the springs being closed. This was a substance which easily set; and immediately after this, the water was introduced into the tank, and he was glad to say the difficulty was overcome, because the tank, though it had been in use from 12 to 14 years, had never had any water put into it since it was first filled, except what the clouds supplied. He remembered being very much perplexed with a tank constructed of cast iron. The excavation was supposed to be free from water; and the contractor evidently thought it was, for he had ceased pumping for a few hours. Then a telegram came saying that "the tank had ripped right across the bottom from the pressure of the water." It was simply a question of pumping. If the contractor had kept the pumps in action, the difficulty would not have arisen. The pumps had to be set to work again; and the cast-iron plates which had been cracked were taken out and renewed. The members were much indebted to Mr. Newbigging for this second paper on the subject of tank construction, which would do a great deal to minimize the difficulties which might arise in their ordinary practice.

Mr. J. WEST (Manchester) said they always expected something practical from Mr. Newbigging; and this paper reminded him of difficulties that he met with years ago, in the construction of tanks, which would have been avoided had they been foreseen; or if they had done as Mr. Newbigging suggested, and bored beforehand, they would then have known the strata they had to deal with. In one case in the South, about five-and-twenty years ago, he had to overlook the construction of a tank designed and arranged by an eminent engineer; and when they commenced operations, they found a bog on three parts of the area of the excavation for the tank, and rock on the rest. He need hardly say they met with many and various difficulties; and the whole construction had to be re-designed at very considerable cost. Had they made previous investigations in the way suggested, this would have been avoided. The great point was to know whither they were journeying, and what kind of material they had to excavate. In another case, some twenty years ago, at Northampton, a tank was erected, and everything seemed perfect. He was not living there, but went down to see it from time to time; and when it was completed, the engineer and everyone connected with it was very proud of it. It was exactly cylindrical, and appeared to be perfect in every way; but within three or four days, they heard that the tank had completely collapsed. The whole thing had fallen inwards, through what Mr. Newbigging had indicated. They had continued to pump, and had drawn away the sand from under the brickwork or foundations of the tank, and also from under the embankment near the bed of the river. It was very fine, soft sand; and the whole thing fell to pieces without any warning. In this instance, he could not imagine how it could have been foreseen. In no case did an engineer require to exercise so much care and foresight as in dealing with an excavation of this sort. There was no "royal road." One must use experience, and judge what course to take on the spot, after having bored to ascertain what was the nature of the ground. In another case in the South, he had to deal with a large quantity of water, gravel, sand, and clay, as he found from borings. There was a large quantity of clay at the depth of about 14 feet. The tank, when finished, was to be 30 feet; and he had to go down a depth of some 35 feet below the bottom—14 feet being of clay. It was at Maidstone, near the side of the River Medway; and the water in the river there sometimes rose 4 or 5 feet in a few hours, though during the summer time it sometimes remained in a normal condition for three or four months. He put down the sump in the usual way outside; but then he came to the conclusion that he would not allow the large volume of water to keep running down into the tank, but would intercept it. He therefore made a little trough all round the top of the clay, which was about 18 inches above the level of the river; and from this he laid an 8-inch pipe about 30 yards to the river. He put a valve on the end near the river, so that, if a flood-tide came, he could shut off the valve, and set the pumps to work. But fortunately it was not found necessary to set the pumps to work at all; for he ran off the whole of the water into the river at a very slight expense, whereas, had he allowed it to go down into the bottom of the tank, it would have cost many hundreds of pounds to pump it out again, besides impeding the progress of the work. [Mr. West drew a rough diagram on the blackboard to illustrate the method adopted.] He was not aware that he could do this until he had reached a certain depth; and this showed the necessity for being very watchful in these constructions, and using one's brains, in order to save as much money as possible. He quite agreed with Mr. Newbigging that the water should not be put into the tank until the gasholder was constructed; and he never knew of such a thing being done. He thought it must be by someone who wished to test the stability of the contractors' work while green, and possibly inflict penalties upon them.

Mr. T. O. PATERSON (Birkenhead) asked if Mr. Newbigging had ever considered the question of the relation between the outside water pressure and the strength of the tank, especially in the lower portion of it. There were

many cases in which one-half the depth of the tank was supported by water when full; and it appeared to him that it might then be quite safe to considerably reduce the strength of the brickwork in the lower portion. If a tank were 30 feet deep, the bottom would have 30 feet head of water upon it, supposing the outside or ground water-line were at the bottom of the tank. But if it rose (say) 15 feet, and were maintained, the tank had only to support 15 feet head of water. The only counterbalancing consideration was the possibility of having the pressure taken from the tank by external means, such as other buildings, and so forth. He would also like to know if Mr. Newbigging considered it safe to put inside the tank a circular drain, carrying water from it up to the sump or stand-pipe, because he had in his mind a tank which was made with a rubble drain inside, and that drain was the cause of the tank giving way twice on the top of the drain. The puddle was affected below, and eventually it gave way to the internal pressure; and the tank had to be emptied.

Mr. R. Mitchell (Edinburgh) said some time ago he had to construct a tank 145 feet in diameter and 37 ft. 6 in. working depth, so that the excavations were 43 feet. The adjoining tank was at a distance of only 23 feet, and was constructed entirely on a bed of rock. Before commencing operations, they sank three shafts, 6 feet by 3 feet, in the line of the excavations. They found on the west, north, and east sides that it was the same rock, according to samples which had been retained from the constructor of the first tank; and they therefore did not think it necessary to put down a fourth shaft on the south side. But this was where they made a mistake; for they found the rock dipped towards the south; and when the excavation was being carried out, instead of having rock on this side, as they expected, they had to take it to the depth of 4 ft. 6 in. below the other portions, and fill it in with strong concrete, so as to bring up the base. The operations of putting down the pump and pumping were carried out exactly as Mr. Newbigging had described; but there was this difficulty to contend with: There was a large public park on the south side, and the under stratum was nothing but peat. They drained the whole of the area, and lowered the level of a portion of it 2 ft. 6 in. Then on the west side were chemical works, where chloroform, ammonia, and other things were made; and these operations were also a cause of trouble. The difficulties attending water pumping, therefore, had to be met in each case according to the circumstances, so that the work might be carried out with the least inconvenience, not only to the contractor, but to adjoining property. As to cutting a trench round the side of the bottom, they had considerable difficulty in this way: In wet weather, having so large an area of spongy ground, the water came in in large volumes; and after the bottom was finished, they put in four stand-pipes about 3 feet above the bottom, and had several of them on the top of the cone. In filling the tank, they closed up these under stand-pipes, filled in as hard as they could, and then blocked up the stand-pipe on the top of the cone. There was no difficulty for a considerable time, until blasting operations were carried on by the adjoining proprietors; and then the tank was wrecked, and they had ever since had trouble. If there was not a good foundation, no matter what care the engineer bestowed on the plans, or the contractor in carrying out the work, difficulties would result; and, as he had pointed out, these might arise from circumstances subsequently occurring, over which one had no control, and which could not be foreseen.

Mr. W. W. Hutchinson (Barnsley) said the members were much indebted to Mr. Newbigging for laying stress upon the proper management of the water in dealing with the construction of a gasholder tank; for in that direction lay the main secret of success. He might say that at Barnsley they had a tank 122 feet in diameter by 30 feet deep, in which they had to contend with all the difficulties Mr. Newbigging had stated, with the exception of the sand. On both sides of the works, there were hills of (say) 250 feet elevation; and the valley was very fully charged with water. Near the tank ran a river, and the winding of it had deposited beds of leaves and other silt and rough stuff of an unstable nature, so that it was impossible to leave the usual mound in the middle. All the ground had to be taken out, and puddled, and concrete put on the top of it. The water was dealt with in the way indicated in the paper. Drains and pipes were laid round the tank, and into a sump; and connected therewith, was a stand-pipe with holes in it at intervals of six inches, tapped for plugs, so that they could be made up afterwards as the water reached them in filling the tank. By these means the water was successfully dealt with. It was within his experience that, if care were not taken, the bottom would have been forced up by the pressure of water from outside. He knew this because, as it happened, the experiment was tried; and in this instance the lifting of the bottom was very distinctly observed. If a sump were made at a suitable level below the tank, and that was kept properly clear until the water was put in the tank at a higher level, all would go well. But there was often great danger of spoiling a tank; and it would most certainly have been so in this case, if it had been left entirely to the contractor, although he was specially charged, in the specification as well as verbally, to see that the operation of filling was properly performed. This tank was made in 1885; and it continued perfectly water-tight to the present time.

Mr. G. B. Irons (Gosport) said there was one subject connected with gasholder tanks which had not been mentioned. One usually required to have attached to the tank a dry well for the inlet and outlet pipes; and he should like to ask Mr. Newbigging if he had ever managed to make such a well, and, if so, how he did it.

Mr. N. H. Humphrys (Salisbury) said the difficulty to contend with in tank construction was, that it very seldom happened that anybody was fortunate enough to carry right through the programme with which he started. Some unforeseen difficulty arose—perhaps in the ground itself, or in unexpected springs, or some neglect by the contractor. It was therefore most important to give close attention to everything which such an experienced constructor as Mr. Newbigging could tell them about it, because they might at any time be called upon, at a day's notice, to contend with some unlooked-for difficulties. One point to which he would direct attention was the question of the section of the wall. A very common arrangement was to start with say 3 feet thickness at the bottom; then, some distance above, to make it two-thirds the thickness; while at the top it was reduced to one-third. He questioned whether this plan of constructing a tank in steps of so great a difference was correct; and whether it would not be better to have it more equalized, by making only two thicknesses, or, in the case of shallow tanks, to have the wall the same thickness throughout, especially when it was built in good ground, because in that case there was support behind the wall at the bottom, but at the top it often had to run 4 or 5 feet above the existing level, with a bank round it. In such a case, one really required almost as much strength at the top as at the bottom.

Mr. H. Ashton Hill (Wallasey) thought the thickness of the wall depended to a great extent upon whether or not it was built in lime or cement mortar; and he was strongly of opinion that cement only should be used in tank construction. If they had a thick wall, it was slow in setting; and the pressure came upon it before it was properly set. But a smaller section, built in cement mortar, would cost about the same, and the result would be more satisfactory. With regard to the point raised by Mr. Humphrys, it had been pretty well established by water engineers, and the common rule was, to make the thickness of the wall 0·3 at the top, 0·5 in the middle, and 0·7 at the bottom, of the total height of the wall. Gasholder-tank walls were much reduced from this, owing to the nature of the backing, perhaps sometimes more than was wise. With regard to the difficulty of dealing with water, no reference had been made to the amount, which was very important. As a rule, the quantities met with were not what would be considered very large, and a comparatively small pumping plant would be sufficient, if suitable. He was now making a well, and had done 138 feet; there being at one part a bed of sandy rock, with harder rocks above and below. The strata were very soft; and at first he provided pumping plant sufficient to raise 40,000 gallons of water per hour. But he found this was becoming too small—having to pump sand and water; and he had now put down pumps to raise anything up to 100,000 gallons an hour. He mentioned this to show the importance of considering the relative quantity of water. Sometimes, if the pumping plant would raise 5000 gallons an hour, it was sufficient; but this was comparatively a teacupful.

Mr. G. Anderson (London) said on one occasion he had

to superintend the construction of a tank which had been undertaken by a man who was thought to have had considerable experience, as he had built the Town Hall in the place. It was on sloping ground; and soon after the operations commenced, he (Mr. Anderson) went down to see how they were getting on. He found the walls with 2 or 3 feet up, and a very small stream of water was coming in at the upper side of the slope. He told the contractor that he ought to lead this round outside the puddle, and get rid of it. However, no attention was paid to it; and, in about another week, he was asked to come down, because the contractor was in difficulties. He found the brickwork looking as if there had been an earthquake; the wall had gone in all directions. This was solely in consequence of the contractor not having attended to that little drop of water. The directors of the company asked him to take over the work and get it done. He took the whole thing out, preserved the puddle, cleaned the bricks, and prepared to begin again. The water was a very small stream—not so thick as a walking-stick; and by simply leading it round outside the puddle it flowed away of itself, and the tank was built without any trouble whatever. This showed how a small thing would cause disaster, if the physics of the question were not understood.

Mr. NEWBIGGING, in reply, said he was pleased with the discussion. In taking up the question of the difficulties associated with water in the construction of tanks, he had rather endeavoured to deal with general principles, not so much to accumulate examples, or he might have given a great many curious instances of troubles encountered and overcome if he had searched through the volumes of the JOURNAL OF GAS LIGHTING. But he was in hopes that members present would recount the difficulties they themselves had met with. Mr. Hepworth had given an interesting description of his trouble in constructing a cast-iron tank, which reminded him (Mr. Newbigging) of an accident to an annular tank at a works not far distant from London. The tank, if he remembered rightly, was being made on a gravel foundation, which he believed was considerably charged with water. The workmen had omitted to leave out certain plugs in the bottom of the tank to admit the water (because in that case it ought to have been admitted). The consequence was that one night the whole tank was lifted by the outside water—in fact, it was floated about in the trench just as if it were a vessel in mid-ocean; and when it came to be landed, it was found to be considerably tilted, and the restoring of it to its proper position was a matter of much difficulty and expense. Mr. West had not exaggerated the danger of pumping water out of sand where there were buildings near; and he had also given some interesting examples from his own experience. He (Mr. Newbigging) could assure him that some directors of gas companies and gas committees of local authorities insisted on tanks being filled before the holders were put in, which was a great mistake. A new tank should always stand for a time, to allow of the masonry becoming properly set. Mr. Paterson had inquired if he had ever considered the question of tank walls. Of course he had done it often enough; but it scarcely came within the purview of the present paper. Besides, in "King's Treatise on Coal Gas," ample rules were given for calculating the strength of tanks of different depths. Something depended upon the character of the outside soil, as to what the strength of a tank wall should be. But whether or not there was water in the outside soil, in his opinion the section of wall should always be strong enough to resist the inside pressure, assuming the absence of water outside to act as a counterbalance. Circumstances might easily arise to drain off the outside water. Mr. Mitchell, recounting his own experience, remarked that there were circumstances over which an engineer and contractor had no control. This was so, no doubt, at the beginning of the work. But as it proceeded, the engineer ought to bring his judgment to bear to grapple with the difficulties that arose; and before the tank was completed, there should be no circumstances hidden from him which he could not control, however it might be at the beginning—he should have been able to provide for them all. If, for example, there was danger at any future time of water being removed from below the bottom of the tank, the engineer was to blame for not either piling it, or going down to a solid foundation. Mr. Hutchinson had referred to the necessity of seeing that the pressure below the tank bottom was kept down until the tank was filled. That could only be accomplished by pumping; and it was most important to see that this was done, if the tank was not to be permanently injured. In case it could not be done, there should be an opening made to allow the water to rise until everything was finished and the stand-pipe put in. Mr. Irons asked his (Mr. Newbigging's) opinion as to whether it was possible to make a dry-well tight. Honestly, he had met with a tight dry-well; but the instances were very rare. By far the best method of dealing with this matter was to dispense with the dry-well altogether. There was no necessity for it; it was an obsolete construction entirely. What was the use of it? Assuming there was a leakage in the inlet or outlet pipe, it was impossible for anyone to go down into the well to remedy it. Anyone venturing down would scarcely return; and the presence of a light would cause an explosion. There was no necessity whatever for a dry-well, no matter what might be the size of the tank. It was entirely abandoned by gas engineers; and therefore the question was really not worth discussing. He could quite agree with what Mr. Humphrys had said about the "stepping" of the tank wall; but, after all, a great deal depended on the circumstances. There were well-known rules for calculating the strength of walls. Mr. Hill, who had had large experience in hydraulic works, could, no doubt have given some interesting instances of difficulties overcome, if there had been more time. He spoke of the trouble in dealing with water in the construction of tanks as not being of a formidable character. The members were indebted to Mr. George Anderson for his description of the ingenious means he adopted in dealing with the water in the excavation of a tank in the course of his practice. It must be remembered that, in building a tank, the object to be attained was a water-tight structure. There was a lot of work for an engineer to do, where he had water to contend with. But then his special construction when finished, might not have to contain water; so that it did not matter how much difficulty he had in the course of the work, he would get rid of the water undoubtedly by some rough means. The thing was to deal with it effectually, and still make a water-tight structure. Building a tank was not like making a long line of railway, or even a reservoir, because they were necessarily limited to a confined space. There was not much elbow-room; and that increased the difficulty. This was also the reason why a tank was more costly, in proportion to its size, than almost any other kind of engineering work.

PAPERS READ AT THE MEETING.

(*Continued from p.* 1177)

STRUCTURAL CAPACITY AND COST OF GAS WORKS.

By WILLIAM REGINALD CHESTER, of Nottingham.

The subject I have chosen for my paper is one of perpetually recurring interest to gas engineers; and yet it is one which, in its entirety, has never to my knowledge before been dealt with at our annual meetings. Why, I do not know, unless it may have been considered too wide a subject to be adequately dealt with in the brief time at our disposal for the reading and discussion of a paper. Only once in a presidential address to one of the District Associations, in 1887-88, has it received the consideration its importance and general interest deserve. Mr. V. Wyatt then dealt with it in a very able manner; and from his wide and exceptional experience as former Chief Constructing Engineer to The Gaslight and Coke Company, his tables of cost and capacity have stood as a text-book for comparison and reference to all engineers interested in the design and construction of gas-works. As, however, the basis of his calculations has reference to the construction of a works exceptional both as regards site and capacity, and as since the construction of the Beckton works immense strides have been made in the production, purification, and storeage of gas, I have ventured to bring the subject forward again; and as I deal with a works in most respects of modern design and of more ordinary capacity, I trust the figures will be found to have a more general interest, and to be of wider application.

In the table at the end of the paper some of the figures

refer to works not executed or designed by the author, but which are in actual existence and form part of a whole which it is the object of the paper to describe. The other figures relate exclusively to works designed and carried out by the author, and which may be taken as representing approximately the proportions deemed best suited for the work to be done. I have preferred to give, in all cases where possible, the actual capacities and costs of existing work, rather than to describe a hypothetical or ideal works, which may never have an existence. I am dealing with a works which constitute one branch of a gas undertaking, and which during the winter months are worked up to their full capacity—the yearly increment being provided for at another station.

The works have a maximum daily output of 3½ million cubic feet of gas, and carbonize 336 tons of coal per day, or a yearly output of 686 million cubic feet of gas from (say) 66,000 tons of coal carbonized.

Land.—The area of the land is 25,848 square yards, or 77 square yards per ton of coal carbonized, or 1·53 acres per million cubic feet of gas per day. This is too small an area for comfortable working; and the coal and coke storeage space is consequently limited. Two acres per million per day would be a more satisfactory area for works of this magnitude. The present site of the works being in the heart of the town, is very valuable, and would if carried out at its present actual value constitute too large a proportion of the cost of the undertaking. I, therefore, for the purpose of this paper, take it, including the boundary-wall and drains, at about £1000 per acre, or (say) £5500, which gives £16·4 per ton of coal carbonized as capital under this head.

Retort-Houses.—The retort-houses, two in number, were constructed many years ago. The ground-floor is 196 feet in length, 50 feet in width, and 24 feet high, from floor to top of walls—235,200 cubic feet each. They have been adapted for regenerator furnaces by excavating the interior to a depth of 9½ feet below the floor-line; underpinning the walls; and providing them with a new floor of cast-iron plates supported on wrought-iron rolled joists. The cost of the conversion is included in the cost for the regenerator settings. In each house there are sixteen settings of eight 18 ft. 6 in. through retorts, regenerator fired, provided with self-sealing mouthpieces and lids; 6-inch ascension-pipes; and wrought-iron hydraulic mains, having separate divisions and a combined weir and flushing-out valve to each bed, as well as a relief main on each side of the stack. The coal carbonized is 168 tons per retort-house per day, which gives 17·14 cwt. per foot lineal of house, and 13·12 cwt. per mouthpiece (5-hour charges).

The cost is as follows:—

			Per Ton of Coal Carbonized per Day.
Retort-house	£5,000	..	£29·76
Chimney	900	..	5·36
Regenerator settings complete with all fittings	8,100	..	48·21
	£14,000	..	£83·33

The houses are too narrow to be worked by machinery, or even comfortably by hand. The conversion from ordinary direct-fired settings to regenerator settings increased the output 78 per cent.

Coal-Stores.—The covered-in coal-store is equal to 180,000 cubic feet, or about 14 days' maximum consumption; and another 14 days' consumption is stacked in the open. The area of land covered and uncovered, used for stacking purposes is 2666 square yards, or about 8 yards superficial per ton of coal per day. The shedding consists of wrought-iron slated roof, supported on columns and open all round. The cost of same at 40s. per yard superficial is £2666, or about 12s. per ton of coal stacked, the interest on which at 5 per cent. adds 7¼d. per ton on the coal stacked under cover. The capital outlay per ton of coal carbonized per day is £7·93.

Coke Storeage.—The coke storeage is all under cover. The sheds consist of wrought-iron roof, slated, supported on cast-iron columns, 11 feet high; and they are open at the side. They have a capacity of 246,000 cubic feet, and will hold about 2000 tons of coke or 14 days' maximum make. The sheds cover an area of 2489 square yards, which gives 7·40 yards superficial per ton of coal carbonized per day. The cost of same, at 36s. per yard superficial, is £4480, or £13·33 per ton of coal carbonized per day.

Siding accommodation inside works.—The siding accommodation inside the works consists of 533 yards lineal of single line of rails, including three turntables and three weighing machines. This gives 1·59 yards run per ton of coal per day. The cost, including turntables and weighing machines, is £1200, or £3·58 per ton of coal per day.

Condensers and Coolers.—The condensers are all atmospheric; part under cover and part outside. I include as condensers all pipes from the mouthpiece to the outlet pipes of the condensers, where the same enters the ground *en route* to the exhausters.

—	Surface exposed to Atmosphere.		Cubical Contents.	
	Sq. ft.	Per 1000 c. ft. per day. Sq. ft.	Cub. ft.	Per 1000 c. ft. per day.
Ascension-pipes, bends, &c.	16,256	4·63	2,200	0·63
Hydraulic mains, and relief main	8,240	2·35	3,248	0·92
Internal pipes, chiefly wrought iron	5,976	1·70	2,984	0·85
External pipes, cast iron	16,216	4·63	6,008	1·72
	46,688	13·31	14,440	4·12

The surface area of the internal and external condenser pipes proper is 6·33 feet superficial per 1000 cubic feet of gas passed per 24 hours; but for the purposes of comparison it is necessary to include also the surface area of the ascension-pipes, hydraulic main, and relief main too; and this brings the total condensing surface up to 13·31 square feet per 1000 cubic feet of gas passed per day. The time contact, including the whole of the above pipes, is about 6 minutes—a period I consider barely sufficient to allow of the adequate deposition of all tarry matter. The cost of condensers proper—*i.e.*, the internal and external pipes, together with wall brackets, valves, foundations and tar troughs—is £4000, or £11·90 per ton of coal carbonized; the cost of the other pipes being included in retort-settings.

Steam-Boilers.—There are two steam-boilers, each 28 feet by 7 feet, Lancashire type, fitted with Perret's patent dust-fuel furnaces, and dry-air fans. The boiler-house forms part of a large block of buildings 48 ft. 10 in. long, and 26 ft. 6 in. wide; room being left for a third boiler of similar type. The cost is as follows:—

			Per Ton of Coal Carbonized per Day.
Boiler-house	£1000	..	£2.98
Chimney	765	..	2·28
Boilers, steam-pipes, & setting	1325	..	3·94
	£3090	..	£9·20

Engines and Exhausters.—There are three sets of engines and exhausters; each exhauster being coupled direct to a separate engine. Two exhausters are of 100,000 cubic feet per hour capacity, and one of 60,000 cubic feet per hour capacity. Any two of these working together at a moderate speed of (say) 100 revolutions per minute, will deal with the maximum make of gas. In the engine-house are placed the tar, liquor, and water pumps, and also an engine and dynamo for incandescent lighting for the whole block of buildings. This latter is provided for lighting purposes, in preference to gas, on account of its greater safety; this being a matter of considerable importance, especially in the purifier-house.

Engine-house	£1200
Engines, exhausters, &c.	1500
Pumps	200
Engine and dynamo	200
	£3100

This works out to a cost of £9·22 per ton of coal carbonized per day.

Scrubbers and Washers.—There are two tower scrubbers, each 12 feet diameter and 60 feet high, filled with 7-inch by ⅜-inch deal boards placed on edge; and one Kirkham "Standard" washer 21 ft. 6 in. by 9 ft. by 9 ft. 6 in. with twelve chambers. The two scrubbers are used with ammoniacal liquor, and the washer with clean water for finishing the ammonia purification. These are ample for the complete elimination of the ammonia.

Normal Capacity—	
Scrubbers each	80,000 cubic feet per hour.
Washer	100,000 " " "
Cubical Capacity—	
Scrubbers	13,570 cubic feet.
Washer (1560 cubic feet) half gas space	780 " "
	14,350 cubic feet.

This gives 4·10 cubic feet per 1000 feet of gas made per

day, or time-contact slightly under 6 minutes. The items of cost are :—

Scrubbers and connections	£2700
Washer „ „	1950
	£4650

or £13·84 per ton of coal carbonized.

Purifiers.—The purifiers consist of eight boxes of a total area of 8568 square feet, and of a cubical capacity (boxes only) of 49,682 cubic feet. This gives an area of 2·44 square feet and a capacity of 14·19 cubic feet per 1000 cubic feet of gas per day—the time contact being 20 minutes. The purifiers are arranged in two sets of four each. The whole number of purifiers in each set are worked together, except during the short period of charging and discharging. The purifying material is lime and oxide in alternate boxes; and in this way the sulphur compounds are kept down to an average of 14 grains per 100 cubic feet without difficulty. The lime is almost completely carbonated, and is removed from the purifiers in an innocuous and inoffensive condition. I mention this in some detail as the process of working is simplicity itself, and gives rise to no anxiety as to results. The low average of sulphur compounds is maintained from week's-end to week's-end with a variation of not more than 2 or 3 grains; and the lime, being almost inodorous, gives rise to practically no nuisance, though the working is in the heart of the town. The purifier-house in one set consists of an open shed composed of a wrought-iron roof, slated, and carried on cast-iron columns, on which the travelling crane runs. The other purifier-house is a brick building forming part of a large block. The purifiers are placed about 10 feet above the ground-line; and the floor below is used for lime and oxide preparation. The area of the purifier-houses is—

Open shed	5,742 sq. ft.
Brick building	7,980 „
	13,722 = 3·92 sq. ft. per 1000 c. ft. of gas per day.

In addition to the purifier-houses there are two sheds for the storeage of new and spent lime, having a combined area of 3850 feet superficial, or 1·10 feet superficial per 1000 cubic feet of gas made per day. The cost is as follows :—

		Per Ton per Day.
Purifier-houses and oxide floor	£5,700 =	£16·96
Purifiers complete with "Goliaths"	8,300 =	24·70
New and spent lime stores	1,400 =	4·17
	£15,400 =	£45·83

Meters and Governors.—The station meters and governors are placed in the same room as the engines, exhausters, and pumps. There are two station-meters each of 100,000 cubic feet per hour capacity; and four station governors. The cost is—

Meter and governor house	£1,200
Meters	2,000
Governors	400
	£3,600 = £10·71 per ton of coal carbonized.

Gasholders.—There are four gasholders of a total capacity of 1,430,000 cubic feet, equal to 0·4 day total production. They were formerly two-lift, now converted into four-lift holders, with a total capacity of 2,740,000 cubic feet, equal to 0·78 day production. The upper lift goes out beyond the guide-framing; being supported by the Pease wire-rope arrangement.

The cost of gasholders and tanks is as follows :—

Original storeage	£42,900 =	£30 per 1000 c. ft. capacity.
New „	13,100 =	£10 „ „
	£56,000 =	£20·07 „ „

The total cost of gasholder storeage equals £166·66 per ton of coal per day. This is a very high figure—due, firstly, to the small capacity of the original holders; and, secondly, to difficulties met with in the construction of the tanks, the bottoms of which are carried some 10 or 12 feet below the surface level of the water in the adjoining river. Storeage capacity of equal dimensions could now be provided at probably half the above cost.

Tar and Liquor Wells.—The tar and liquor wells are placed beneath the revivifying floor of the purifier-house. They are 91 feet by 87 ft. 8 in. by 11 ft. deep; giving a total available storeage capacity equal to about four weeks maximum make. The cost was £2400 = £7·14 per ton per day. In addition to the above there are overhead tanks for water, tar, and liquor, placed above the boilers. These cost £1250 = 2s. 2d. per cubic foot (nearly), or £3·72 per ton of coal carbonized.

Store-Rooms and Workshops.—The store-room is above the engine-house; and the smiths, and fitting-shops adjoin the retort-houses. The cost is £1340 = £4 per ton of coal carbonized.

Stabling for five horses, including two loose-boxes, is provided at a cost of £500 = £1·48 per ton of coal carbonized.

Works Superintendent's House and Offices.—Cost £1000 = £3 per ton of coal.

Mains and Connections between various apparatus. Cost £1000 = £3 per ton of coal.

Tools, Implements, Horses, Carts, and Rolling Stock.—I estimate these at £6720, or £20 per ton of coal carbonized.

TABLE *showing Cost per Ton and per* 1000 *Cubic Feet of Various Parts of Gas-Works, and Ratio of Parts to the Total Capital.*

—	Total Cost.	Cost per Ton of Maximum Daily Consumption of Coal.	Cost per 1000 c.ft. of Maximum Daily Make of Gas.	Cost per Ton of Annual Consumption of Coal.	Cost per 1000 c.ft. of Annual Make of Gas.	Ratio. Percentage of Total.
	£	£	£	£	£	
Land, drains, and boundary-wall	5,500	16·37	1·571	·0833	·0080	1·73
Retort houses and benches	28,000	83·33	8·000	·4242	·0408	8·80
Coal-stores	2,666	7·93	0·762	·0404	·0039	0·84
Coke-storeage	4,480	13·33	1·280	·0679	·0065	1·41
Siding accommodation, including weighing-machines and turntables	1,200	3·57	0·343	·0182	·0018	0·38
Condensers and coolers	4,000	11·91	1·143	·0606	·0058	1·26
Steam-boilers and boiler-house	3,090	9·20	0·883	·0468	·0045	0·97
Engines, exhausters, pumps, and house	3,100	9·23	0·886	·0470	·0045	0·97
Scrubbers and washers	4,650	13·84	1·328	·0705	·0068	1·46
Purifiers and house	15,400	45·83	4·400	·2333	·0225	4·84
Meters, governors, and house	3,600	10·71	1·029	·0545	·0052	1·13
Gasholders	56,000	166·67	16·000	·8485	·0816	17·59
Tar and liquor wells	2,400	7·14	0·686	·0364	·0035	0·75
Overhead tanks—tar, liquor, water	1,250	3·72	0·357	·0189	·0018	0·39
Store-rooms and workshops	1,340	3·99	0·383	·0203	·0020	0·42
Stabling for five horses	500	1·49	0·143	·0076	·0007	0·16
Works Superintendent's house and offices	1,000	2·98	0·286	·0151	·0015	0·31
Mains and connections in yard	1,000	2·98	0·286	·0151	·0015	0·31
Tools, implements, horses, carts, and rolling stock	6,720	20·00	1·920	·1018	·0098	2·11
Mains and services	91,000	270·83	26·000	1·3788	·1327	28·59
Meters	35,700	106·25	10·200	·5409	·0520	11·22
Floating capital	23,520	70·00	6·720	·3564	·0343	7·39
Engineering and parliamentary expenses	22,184	66·02	6·338	·3361	·0323	6·97
	318,300	947·32	90·944	4·8226	·4640	100·00

REMARKS.

Land.—1·53 acres per million, 77 yards superficial per ton. *Retort-Houses.*—17·14 cwt. per foot lineal. *Coal-Stores.*—Covered space 4 yards superficial per ton of coal per day (maximum). *Coke-Stores.*—Covered space 7·4 yards superficial per ton of coal per day (maximum). *Siding Accommodation.*—1·59 yards lineal per ton of coal per day. *Condensers.*—13·31 feet superficial, 4·12 cubic feet per 1000 cubic feet per day; time contact, 6 minutes. *Boilers.*—Boilers, 43 per cent.; house and chimney, 57 per cent. *Engines.*—Machinery, 61 per cent.; house, 39 per cent. *Scrubbers.*—4·1 cubic feet per 1000 cubic feet per day; time contact, 6 minutes. *Purifiers.*—House, 37 per cent.; apparatus, 54 per cent.; sheds, 9 per cent. Area = 2·44 feet superficial; 14·19 cubic feet per 1000 feet per day; time contact, 20 minutes. *Meters and Governors.*—House, 33⅓ per cent.; apparatus, 66⅔ per cent. *Gasholders.*—0·78 day maximum make, £20 per 1000 cubic feet capacity. *Tar and Liquor Wells.*—Four weeks' maximum make; £6·38 per 1000 gallons. *Tar, Liquor, and Water Tanks.*—2s. 2d. per cubic foot. *Mains and Services, and Meters.*—£711 per mile, 139 consumers per mile for each item. *Floating Capital.*—7s. per ton of coal (should be 10s.). *Engineering, &c.*—7½ per cent. on previous items.

Meters.—The number of meters in use, corresponding to the number of tons of coal carbonized, is 17,800, the cost price of which fixed would be £35,700. This gives £106·25 per ton of coal carbonized per day.

Mains and Services.—There are 128 miles of mains, the cost of which (including services) is £91,000, or £711 per mile of main. This gives a capital outlay of £270·83 per ton of coal carbonized per day. The number of consumers per mile of main works out at 139—reckoning one consumer to each meter. Each consumer takes, on an average, the gas from 3·70 tons of coal, and pays for about 36,000 cubic feet of gas per annum.

Floating Capital.—The floating capital employed is £23,520, or £70·00 per ton of coal carbonized per day. This works out slightly over 7s. per ton on the total quantity of coal carbonized; and it is scarcely sufficient for the proper working of a gas undertaking. In the writer's opinion, it ought to be equal to 10s. per ton of coal carbonized per day.

Engineering and Parliamentary Expenses are estimated at 7½ per cent. on the previous items = £22,184, or £66·02 per ton of coal carbonized per day.

The structural cost of the undertaking now under consideration works out at £4·82 per ton of coal carbonized; and this figure represents as near as possible the actual cost of a works of 3½ million cubic feet per day capacity.

The capital charge of the whole undertaking at Nottingham is £6·35 per ton of coal carbonized; but this includes a large portion of reserve land and buildings provided for future extension, a considerable sum paid for goodwill, the provision of handsome show-rooms and workshops, and the whole of the capital expended on chemical works, which deal with the residual products (tar, liquor, and spent oxide), provide sulphuric acid, and manufacture all the requirements of new oxide.

If a new works were being laid out, it would be possible to economize in some of the items; but a substantial works of this magnitude—built for posterity, and not merely to serve the purpose of to-day—I consider, could be provided fully equipped for £4 per ton of coal carbonized, the interest on which at 5 per cent. would be covered by a charge of a little less than 4¾d. per 1000 cubic feet of gas sold.

Although I cannot pretend that the capacities referred to herein are in all respects best suited for the work, or the costs the most economical that can be attained, I have, in dealing with this subject, throughout endeavoured to avoid speculation, believing the record of an actual fact to be of infinitely more value as a guide than any hypothetical figure which may vary with the vividness of the imagination or with the bias or momentary self-interest of the individual; and this must always be borne in mind when referring to the table annexed.

The author exhibited a series of drawings referring to work actually in process of construction.

NOTES ON THE CARBURETTING OF GASES.

By Vivian B. Lewes, F.I.C., F.C.S.

I have on several previous occasions given my experimental results and views on the subject of the enrichment of coal gas by carburetting materials other than cannel; and the wide-spread interest which is now being taken in the subject, encourages me to believe that some further notes on the subject may not be unwelcome.

From the gas manager's point of view, the great end and aim is to enrich a 15 to 16 candle coal gas up to 17 to 22 candle value. But in the experiments I have made, I have gone beyond this, and have tried how far it is possible, within the limits of price necessary to compete with coal gas, to endow non-luminous gases with the illuminating power required to make them available for either enrichment, or for consumption by themselves.

It is manifestly useless to discuss the use of such substances for enrichment as could not be obtained in sufficient quantity to render them available at a cheap rate, in the event of experience teaching us that good results could be obtained from them; as the increased demand, consequent on the opening up of a large market for them, would at once send up the price to a figure which would render their use impossible. This consideration, I fear, limits our carburetting materials to Russian and American petroleum; and the cost of carriage points clearly to the former as being the chief factor in our calculations. In a series of experiments, the results of which I gave a short time ago, I found that the Russian crude and "distillate" oils gave the best results as far as the manufacture of an illuminating gas was concerned; and that the Scotch intermediate oils were nearly as good, and did not give as much trouble from deposition of carbon. But, unfortunately, the native product could not be obtained in sufficient quantity to meet any very large demands; and the present condition of the Scotch oil industry does not encourage much hope of an increase in this direction.

The enrichment of a poor coal gas, or the rendering of a non-luminous gas capable of giving light during its combustion, may be brought about either by charging it with the vapours of highly volatile hydrocarbons, or by admixture with rich oil gas made by decomposing oil by means of heat into a mixture of permanent gases rich in hydrocarbons; and it is with certain points in these two methods that I wish to deal in this paper.

Taking first the case of enrichment of a poor coal gas by means of a rich oil gas, the question which occurs at the outset is how much of the enriching gas must be added in order to raise the illuminating value to the desired point. The general idea which prevails is that the illuminating value of the mixture will be directly proportional to the quantity and quality of the enriching gas added and the value of the gas enriched. But this by no means follows, as the composition of the gas employed to dilute the oil gas exercises a very distinct influence upon the illuminating value obtained.

In a paper read last month before the Incorporated Institution of Gas Engineers, by Mr. A. F. Browne, he gives a formula for calculating the percentage of rich gas which must be added to a poor sample of coal gas in order to raise it to the desired value, and a second formula for finding the volume of enricher to be added for 1000 cubic feet of the coal gas. These formulæ he verified by making mixtures of coal gas and oil gas; and on testing the resultant illuminating values, he found that they were "very fairly in agreement with theory."

Coal gas is a mixture of many gases and vapours; and if the constituents of the coal gas be taken separately and be enriched with oil gas, or with a rich hydrocarbon gas of definite composition—such as ethylene—it will be found that some of the constituents require a far higher percentage of enricher for a given rise in value than others. Taking the illuminating gas supplied by the South Metropolitan Company (which I presume was used in Mr. Browne's experiments), an analysis made last month gave as its composition—

South Metropolitan Gas—May 16, 1892.

Hydrogen	52·22
Unsaturated hydrocarbons—ethylene, benzene, &c.	3·47
Saturated hydrocarbons—methane, ethane, &c.	33·76
Carbon monoxide	6·23
Carbon dioxide	0·60
Nitrogen	3·23
Oxygen	0·49
	100·00

Of these constituents, the unsaturated and saturated hydrocarbons alone are of value as giving illuminating power; the other gases being merely diluents. The hydrogen and carbon monoxide, however, being combustible, have a definite part to play in the flame, whilst the non-combustible diluents, carbon dioxide, nitrogen, and oxygen, are the gas manager's worst foes, and simply reduce the illuminating value of the gas.

In the following experiments, I have first tried the effect of enrichment by known percentages of oil gas upon the original coal gas, and then upon the combustible diluents separately. The oil gas for this purpose was made by decomposing Russian distillate oil at 1600° Fahr. in a Patterson oil-gas plant; collecting the gas in a 400 cubic feet holder; and running the right proportions into experimental holders into which the diluting gas was afterwards passed, and the mixture allowed to stand all night to ensure thorough mixing. In testing the various mixtures, the gas was burnt at the burner which suited it best; and the rate of flow was regulated to give the most perfect obtainable flame, and the consumption of gas calculated to 5 cubic feet per hour. The whole of each mixture was burnt; tests being taken every half hour, so as to ensure the detection of imperfect mixing—the mean of the tests being taken as representing the illuminating value of the

gas. All tests were taken on an Evans-Sugg photometer with the usual precautions and corrections.

Taking first the coal gas, and enriching it with oil gas, the following results were obtained :—

Illuminating power of the original coal gas . . . . . 13·43 candles
Illuminating power of the oil gas . . . . . 48·90 „

Percentage of Coal Gas.	Percentage of Oil Gas.	Illuminating Power of the Mixture. Found.	Calculated.
95	5	16·2	15·20
90	10	17·5	16·97
75	25	23·2	22·29
50	50	32·3	31·16
25	75	44·5	40·02

The coal gas used was rendered poor in illuminating value by standing for some time; and the results clearly show that a considerably higher result is obtained than would be expected from calculation.

Having determined the result of diluting the rich oil gas with coal gas, the next step was to find out how the chief diluents acted towards the enricher. Hydrogen being the most abundant constituent of the coal gas, was tested first; the same methods of testing being observed as in the case of the coal gas. The hydrogen used contained 99·6 per cent. of the gas; and, as before, the oil gas was first put into the test holders and the hydrogen then added, the same precautions being taken to ensure mixing as before :—

Set I.

Illuminating value of the original oil gas . . . . . 49·6 candles.

Percentage of Hydrogen.	Percentage of Oil Gas.	Illuminating Value of the Mixture. Found.	Calculated.
33·3	66·6	34·2	33·0
50·0	50·0	25·5	24·8
66·6	33·3	18·2	16·5

Set II.

Illuminating value of the original oil gas . . . . . 42·8 candles.

Percentage of Hydrogen.	Percentage of Oil Gas.	Illuminating Value of the Mixture. Found.	Calculated.
25·0	75·0	32·8	32·1
50·0	50·0	23·9	21·4
60·0	40·0	21·0	17·1
66·6	33·3	12·4	14·2
71·4	28·5	9·0	12·2

These experiments show that, with hydrogen gas, the illuminating value of the mixture is higher than one would expect from calculation for candle powers higher than 18; but that when diluted below that value, the excessive dilution causes a loss of illuminating power, and so necessitates a larger addition of the enriching gas than that calculated.

Some years ago, Dr. Percy Frankland read a paper before the Chemical Society* upon the effect of diluents upon ethylene; and his figures reveal the same fact—

Illuminating value of the ethylene . . . . . 68·5 candles.

Percentage of Ethylene.	Percentage of Hydrogen.	Illuminating Value of the Mixture. Found.	Calculated.
77·55	22·45	54·58	54·28
68·39	31·61	49·37	47·87
53·58	46·42	39·21	37·50
35·47	64·53	30·85	24·82
26·08	73·92	22·84	18·25
13·37	86·63	6·73	9·35

The next combustible diluent experimented with was carbon monoxide, which has an interest for us as being not only the cheapest combustible gas but also the most poisonous; the numerous accidents which have arisen from the use of water gas being due to its presence.

Illuminating value of the original oil gas . . . . . 54·7 candles.

Percentage of Carbon Monoxide.	Percentage of Oil Gas.	Illuminating Value of the Mixture. Found.	Calculated.
90	10	unreadable	5·4
75	25	8·94	13·6
50	50	21·50	27·3
25	75	38·40	41·0

These experiments show that even when only a small percentage of carbon monoxide is used, it has a tendency to reduce the illuminating value of the mixture; whilst in order to make a 17 or 18 candle power gas with carbon monoxide as the basis, a very large excess of hydrocarbon gas would have to be used.

In Frankland's experiments with ethylene and carbon monoxide the results obtained were—

Illuminating value of the original ethylene . . . . . 68·5 candles.

Percentage of Carbon Monoxide.	Percentage of Ethylene.	Illuminating Value of the Mixture. Found.	Calculated.
18·35	81·65	55·27	55·93
32·25	67·75	47·73	46·40
53·70	46·30	33·09	31·71
62·06	37·94	26·52	25·97
71·27	28·73	13·26	19·64
76·11	23·89	6·56	15·86
80·00	20·00	0·00	13·70

* See JOURNAL, Vol. XLIV., p. 17.

Showing an even greater loss of illuminating value in the more diluted mixtures.

Having seen that admixture with hydrogen gives higher results than would be expected, whilst the carbon monoxide seriously detracts from the illuminating value, it might be expected that with water gas—a mixture of the two, theoretically in nearly equal proportions—the one would neutralize the other, and that the results obtained would be nearly proportional to the amount of oil gas used. Experiment, however, shows this not to be the case; the loss in illuminating value being as great as with the carbon monoxide alone.

Illuminating value of the original oil gas . . . . . 54·7 candles.

Percentage of Water Gas.	Percentage of Oil Gas.	Illuminating Value of the Mixture. Found.	Calculated.
90	10	unreadable	5·4
75	25	11·9	13·6
50	50	21·6	27·3
25	75	35·6	41·0

These experiments not only show the fallacy of supposing that it is possible to calculate the amount of enriching gas which it is necessary to add in order to attain a given illuminating value without first taking into consideration the composition of the gas to be enriched, but also give interesting information on the important subject of the carburetting of non-luminous gases.

In a paper read before the Incorporated Institution of Gas Engineers last month, I showed by experiments that it was impossible to obtain the same illuminating value from oil "cracked" by itself, as could be got by decomposing it in an atmosphere of an inert gas such as hydrogen or water gas; and these further experiments show the great superiority of hydrogen over water gas for this purpose.

Up to the present time, the price of water gas has rendered it the only one available for carburetting and using either for enrichment or by itself; but by a process which I have devised and shall shortly be working on a small manufacturing scale, I believe I can make hydrogen as cheaply as, or indeed a shade cheaper than, water gas; and as the use of this would do away with all the objections urged against water gas, with its high percentage of deadly carbon monoxide, and would be more economical to carburet, I am in hopes that it will play a very important part in the near future.

The varying effect exercised upon enriching gases by the different diluents, is not due to one cause only, but to several acting in unison. In the first place the illuminating power of a flame is to a great extent governed by temperature. The hotter the flame, the more readily are the hydrocarbons broken down and carbon liberated; and the light which this emits being entirely governed by temperature, the hottest flame will always give the most light from any given quantity of hydrocarbons. If we take two flames of equal size, the one obtained by burning hydrogen and the other carbon monoxide, it will always be found that the former is the hottest. Taking a jet of hydrogen, 3 inches in height, and a similar one of carbon monoxide, and testing their temperature with a Le Chatelier thermocouple, the hydrogen flame was found to have a temperature of 1488° C. or 2610° Fahr., whilst a carbon monoxide flame of the same size gave a temperature of 1419° C. or 2554° Fahr.

Another cause, however, is, I think, to be found in the fact that, as a carburetted carbon monoxide flame burns, a large proportion of carbon dioxide is produced and drawn into the flame; and this in the luminous zone of the flame attacks the liberated carbon, combining with it to form carbon monoxide again, and so uses up some of the carbon upon the presence of which luminosity depends, whilst the high specific heat of the carbon dioxide tends to cool the flame.

The cause of the increased effect produced by enrichment upon a poor coal gas is to a great extent the methane, which forms a very large proportion of the saturated hydrocarbons, and which, although it is practically non-luminous when burnt alone, yet adds considerably to the luminosity of a mixture; also to the hydrogen, more than 50 per cent. of which is present, and which increases the temperature, and by so doing the luminosity also, whilst carbon monoxide is only present in coal gas in quantities varying from 3 to 8 per cent., so that its effect upon the luminosity of the flame is entirely overshadowed by the increase due to hydrogen and methane.

The enrichment of coal gas and other diluents with the vapours of volatile hydrocarbons has been tried from a

very early period of the history of coal gas; and the late Dr. Letheby made many experiments upon this method of carburetting gas. There is no doubt that, by using an extremely volatile hydrocarbon of definite composition—such as pentane or benzol—it is quite possible to enrich gas to a very great extent; whilst if the gas takes up the hydrocarbon vapour at a temperature below that which it will afterwards encounter, there is no fear of its again depositing. But if gasoline (such as is obtained as the first distillate from American petroleum) is used, the hydrocarbon being a mixture of many compounds, will yield up its more volatile portions first and gradually lose its enriching power; whilst if the vapour is driven off from the hydrocarbon by heat, care must be taken to only supply a small percentage of the vapour. Otherwise it will again be deposited in the gasholder and pipes.

My own experience is that 6-candle power is about the limit it is wise to add to the gas; as, although I have succeeded in carburetting hydrogen with ·680 gasoline up to 14 candles, yet the illuminating value rapidly falls again on standing or passing through any great length of pipe.

The amount of volatile hydrocarbon vapour which will remain as a gas without depositing, is purely a question of vapour tension; and as this increases with a rise of temperature, and falls with diminution of temperature, it is manifest that for a gas to retain its illuminating value, it must be a long way from its point of saturation.

Gas engineers have got into the habit of speaking of the "carrying power" of various gases, and of looking upon one gas as a good carrier of vapours and another gas as a bad one; but this is, I think, an entire mistake, as a volatile liquid will evaporate into other gases at the same rate and practically without reference to the properties of the gas. I have made a series of experiments upon the point, which I think show this fairly clearly.

The gases to be experimented with were carefully prepared and as pure as possible. They were stored in graduated glass gas-jars; and after being carefully dried by passing through three bottles filled with ignited pumice-stone moistened with strong sulphuric acid,* were made to bubble slowly through potash bulbs containing pure benzol. The loss of weight in these, after each experiment, gave the weight taken up by the gas. The temperature, rate of flow, and amount of benzol in the bulbs, were kept as constant as possible during the experiments; and a second set was made, in which the gases were saturated with moisture by passing through water before entering the bulbs containing the benzol.

Gas Used.	Grains of Benzol taken up by a Cubic Foot of the Gas. Dry.	Moist.
Nitrogen	114·71	101·92
Hydrogen	113·85	119·78
Oxygen	114·64	109·64
Air	112·64	108·92
Coal gas	106·07	103·78
Carbon monoxide	103·00	109·42
Carbon dioxide	107·85	103·92
Mean	110·39	108·19

Showing practically the same rate of absorption for each gas; the differences being no greater than would arise from slight and unavoidable alterations in the rate of flow, temperature, and barometric pressure.

In another experiment, in which the pentane supplied for use in Mr. Vernon Harcourt's standard pentane air-gas flame was used, the same thing was found, although the discrepancies were rather larger—

Gas Used.	Grains of Pentane taken up by a Cubic Foot of the Gas.
Hydrogen	961·17
Air	965·60
Oxygen	961·17
Carbon dioxide	912·68

The idea that the quantity of vapour taken up varies with the properties of the gas, is due to the wide divergence in the illuminating power obtained from the carburetted gas; but this is due, not to the quantity of carburetter, but to the action of the diluent gas. Taking equal volumes of ethylene and the following diluents, the results obtained were—

Diluent.	Illuminating Power in Candles per 5 Cubic Feet.
Nitrogen	22·0
Air	28·0
Hydrogen	36·2
Carbon monoxide	34·0
Methane	37·0
Carbon dioxide	15·0

* Calcic chloride was used in the case of the coal gas.

And the results obtained with hydrocarbon vapours vary in almost exactly the same ratio; so that in carburetting hydrogen and carbon dioxide, although each gas would take up the same amount of the enricher, the enriched hydrogen would give more than double the illumination obtainable from the carburetted carbon dioxide. There is another point in enriching with volatile hydrocarbons which must not be lost sight of, and which was experimentally dealt with by Mr. George E. Davis in 1884 and 1886, and again by Mr. T. S. Lacey in a paper read at the May meeting of the Incorporated Institution of Gas Engineers It is that if a rich coal gas be carburetted with volatile hydrocarbons of high vapour tension, they are quite capable of displacing other vapours which are present in rich coal gas, and which have a lower vapour tension, and are often more valuable as illuminants than the vapours which take their place. If, also, a coal gas is enriched by hydrocarbon vapours—especially those derived from American petroleum—and a fall in temperature causes condensation, the condensing members of the paraffin series bring down with them and dissolve ethylene, benzene, and other of the most valuable illuminants of the unsaturated hydrocarbons; so that condensation means not only the removal of the enricher, but also very serious deterioration of the original value of the gas.

The Engineer of the Wolverhampton Water-Works.—In consequence of his advancing years and state of health, Mr. Lyons Wright, who has for a great number of years been the Engineer of the Wolverhampton Corporation Water-Works, will shortly resign that office, and be engaged as Consulting Engineer at a remuneration of £300 a year. A successor to his present position is to be appointed at a salary of £200 per annum.

Meeting of the German Gas and Water Works Managers' Association.—The thirty-second annual meeting of the German Association of Gas and Water Works is being held during the present week in Kiel; beginning yesterday morning. The President for the year is Herr C. Kohn, Manager of the Frankfort Gas Company, with whom are associated Herr E. Kunath, of Dantzic, and Dr. H. Bunte. The programme of the gas portion of the technical work of the meeting contains the following titles of papers to be read: "The New Charlottenburg Gas-Works, and the Mechanical Working of Retorts," by Herr A. Müller, of Charlottenburg. "Retort Charging and Drawing Machinery," by Herr Borchardt, of Remschied. "Settings of Sloping Retorts," by Herr J. Hasse, of Dresden. "Water Gas, and the First District Water Gas Heating in Europe," by Herr Blass, of Essen, and Herr Schendler, of Görlitz. "The Auer Incandescent Gas-Burner," by Herr G. Fähudrich, of Vienna. "The Carburation of Illuminating Gas," by Dr. H. Bunte, of Carlsruhe. "The Estimation of the Heating Value of Gaseous Fuel," by Dr. Bueb, of Dessau. "Electrical Distribution in Towns for Lighting and Power Purposes," by Herr Hohenegg, of the firm of Siemens and Halske, of Vienna. "Sulphate of Ammonia as a Manure," by Professor P. Wagner, of Darmstadt. Besides these there will be the reports of Commissions upon Light Measurement, Heating by Gas, and Gas-Meters. The meeting is arranged to terminate with an excursion to Copenhagen.

Foreign Sewage Precipitation Works.—At the meeting of the Society of Engineers on the 13th inst.—the President (Mr. J. W. Wilson, jun.) in the chair—a paper on "Foreign Sewage Precipitation Works" was read by Mr. A. Wollheim. In the introduction to his paper, the author compared and traced the development of sewage precipitation works, and stated that as yet there were only very few works of the kind in existence abroad. Then, taking for the first part of his subject the works of Germany, he reviewed and detailed the existing legislation for the prevention of river pollution. The most important precipitation works in that country are those at Frankfort-on-the-Maine (population 160,000). They are situated upon the left bank of the river; the sewage from the right bank being conveyed across by two wrought-iron syphons, 2 ft. 6 in. diameter, with a total discharging capacity of 800,000 gallons per hour. The tanks are covered in, and will consist of two groups of six subdivisional tanks each; but only four subdivisions are as yet constructed. They are each 270 feet by 17 feet average width, and 6 ft. 10½ in. average depth of water. Each subdivision holds 250,000 gallons; and as the present daily dry-weather flow is 6,000,000 gallons, the existing tank capacity is 16 per cent. of the total daily flow. The Roeckner-Rothe system of circular upward-flow tanks, as distinguished from the rectangular longitudinal system, was next described; and the author concluded his paper with a brief *résumé* of what has been done in the United States to prevent river pollution. That country is just beginning to stir in the matter; and three precipitation works have been constructed—the largest being those at Worcester (Mass.). They were designed by Mr. Allen, the City Engineer; and well-known English types have been followed—the tanks having been planned somewhat after those at Coventry. Only a portion of the city drains to the works at present; the daily flow being about 3,000,000 gallons. The paper was illustrated by a large number of diagrams.

ESSAYS, COMMENTARIES, AND REVIEWS.

GAS AND WATER COMPANIES IN THE STOCK MARKET.

(For Stock and Share List, see p. 1254.)

THE past week was more than ordinarily quiet in all the Stock Markets. The revival in speculative activity, so long looked for, and which was thought a little while ago to be fairly under weigh, still hangs fire somehow or other. Many would attribute this to the approaching General Election; but it is questionable whether political affairs are justly chargeable with any such responsibility. It must be remembered that public confidence has been rudely shaken for some time past; and that it will take a long while before the loosened foundations are consolidated again. So that, in the meantime, a small but untimely jolt arrests the setting. Perhaps sensitiveness in this respect may be accountable for some of the dulness of the past week. Everything was dull and listless. The Money Market shows no change to record. The minimum rate of discount fixed by the Bank of England—2 per cent.—has now been running for two months, and will hold good for some time yet, bar accidents. The Gas Market, which so frequently chalks out a line for itself, has been much more active, especially when compared with the general run of the markets. But while dealings have been more frequent, changes in value have been extremely restricted and slight. There has been more doing in Gaslight "A" than has been the case in recent weeks, with the result that the stock closed firm on Saturday at the opening price of the week—say 210. The secured issues (debenture, preference, and limited) have not been so much dealt in as of late; but they show no sign of falling off in favour. South Metropolitan issues were left alone, except the "B," which made a slight further fall of 1½. Commercials were quite neglected, and remained unchanged. The Suburban and Provincial undertakings are only noticeable as furnishing the sole other change in quotation—a fall of 1 in British. The Foreign Companies were entirely without any feature; and not a single variation in value is apparent in the entire array. The Water Companies show much more animation; and a firm disposition towards higher prices is apparent. Lambeth leads the way with an advance in all its issues; and Grand Junction has made a 4 per cent. improvement.

With alterations in value so few and far between, it is superfluous to recount daily operations at the same dead level. Be it, therefore, noted that the changes were as follows: On Monday, Lambeth rose 1½; and Grand Junction, 1. On Tuesday, South Metropolitan "B" fell 1½; while Lambeth Water rose 1½. On Friday, British Gas fell 1; and Lambeth 10 per cents rose 2; and ditto, 7½ per cents, 1½. On Saturday, Lambeth 7½ per cents; and ditto, debenture, rose 1 each.

ELECTRIC LIGHTING MEMORANDA.

The Electric Lighting of the Thames Embankment—The Utilization of the Power of the Niagara Falls—The Electric Lighting of the City of Sophia—Parliament and the Electrical Tramways.

IF the recommendation to that effect, of the Highways Committee of the London County Council, is acted upon, as will in all probability be the case, the electric light will blink once more on the line of the Victoria Embankment, which has been (nominally) lit by gas ever since the final collapse of the Jablochkoff Company. In accordance with the ordinary policy of the principal street lighting authorities of London, no attempt has been made during all these years to show what gas could do for this fine line of river frontage. We know not if The Gaslight and Coke Company have tried to do anything to retain this conspicuous piece of lighting—almost the only one, by the way, at the disposal of the County Council—but, at any rate, nothing has been done; and accordingly, in a few months, the electricians will have this capital advertisement of their progress to show. The Council propose to spend £10,000 upon the installation, which is very liberal on their part. It is hardly necessary to remark that not one-half, nor one-quarter, of this sum would have been voted for gas lighting. Well, it is to be hoped the Council will be happy after the money has been spent. A cynic might say the Council are bent upon damaging the most conspicuous relic of their much-abused predecessors, the Metropolitan Board of Works; and so, having been defeated in the attempt to spoil the western end of the Embankment by running an utterly superfluous tramway across Westminster Bridge and along the thoroughfare as far as Charing Cross, they now contemplate the suppression of the picturesque, if insufficient, gas-lamps by flickering arc lamps spaced too far apart to produce anything but a "spotty" effect. We only say it is a pity that the lighting of such a conspicuous part of London—one of the show places, indeed, of the Metropolis—should be lost to gas, which is able to do the work much better and at less cost than the electric arc.

An interesting experiment, the result of which will be watched with the greatest curiosity from all parts of the world, is in preparation at the Niagara Falls. At last a serious attempt is being made to utilize for the service of man a portion of the enormous energy liberated at this spot by the falling water, which has been estimated as equivalent to 4,500,000-horse power. Professor George Forbes is the moving spirit of an enterprise intended to take, by means of turbines, 100,000-horse power of the energy now wasted, from the engineering point of view, at Niagara, and to transmit most of this power to a new manufacturing city in the neighbourhood, where it is to be used in the production of alarm clocks, sewing-machines, and other American contributions to the general stock of accessories of civilization. A few protected factory-owners will make money; a number of factory hands will earn a living suitable to their station in life; and thus the power of Niagara will be utilized. A sublime prospect! Meanwhile, however, the mechanical arrangements for tapping the strength of Niagara are cleverly conceived. They comprise a canal 1500 feet long above the Falls; a vertical shaft in the rock 140 feet deep; and a discharge tunnel 6700 feet long at the lower level. In the electrical section of the work, which remains to be carried out, Professor Forbes's ideas are to prevail. These comprise the employment of the alternating current; and, as motors, either the alternating dynamo or the multiphase machine which attracted so much attention at Frankfort last year. This is an innovation on previous practice; and it is a striking illustration of the mutability of opinion, and the fallibility of "authority" in matters electrical, that only in 1890 an international committee of experts, appointed to advise as to the best way of electrically transmitting to a distance the power derived from the turbines, were unanimous (with one exception) in desiring to pass a resolution condemning as impracticable the alternating system which is now to be relied on exclusively.

The negotiations for the provision of a complete electrical supply plant for the city of Sophia, as reported in the *Electrical Review*, are very interesting, and in no small degree instructive. Here was an example such as the writer of technical manuals loves, of a virgin district, to be occupied in any manner and at any cost deemed suitable and necessary by the contracting parties. After two years of preliminary "studies," which do not seem to have amounted to much in the practical way, the Municipality of Sophia opened negotiations with a selected number of electrical firms of European reputation, and gave to them a free hand for the preparation of a complete scheme for which a concession could be granted. The result was a crop of some half-dozen tenders, so divergent and irreconcilable, that the Commission charged with the duty of examining and comparing them could not educe from the available data any trustworthy comparative statement of their merits. Consequently, a fresh start was decided upon; and this time a prospectus of what the city desired was prepared by the Commission for the guidance of the contractors. The result was more satisfactory, inasmuch as the same firms tendered once more; and it was possible to compare the various specifications upon a uniform basis. The competition for the concession was a truly international one; and, in the event, the tender of Messrs. Ganz and Co., of Buda-Pesth, was accepted. The successful firm were, however, run very closely by Messrs. Crompton and Co. It seems only fair and natural that the Hungarian competitors, being nearest the spot, should send in the lowest tender. The driving power is to be water; the generating station being at a distance of 7 kilometres from the city.

Parliament has been very busy lately with various electric tramway schemes for London—all subterranean, of course, and more or less closely following the example of the City and South London Company's lines. There seems to be a tenderness for this class of schemes on the part of Parliamentary Committees which we venture to think is misplaced. The typical example is as yet far from successful in the commercial sense; and when any undertaking is financially weak, it is impossible to regard it as technically strong. In the circumstances, it would be preferable to keep all fresh electrical subterranean tramway schemes, whether for London or the provinces, in abeyance for a year or two; and this would doubtless be done in any country where statutory facilities for such ventures happened to be dealt with logically, and with reference to the subject as a whole. In England, where everything of the kind is done piecemeal, it is quite possible for electric tramways to be sanctioned for different places, without reference to one another or to the fact that the only example of the kind has its £10 shares quoted at something less than one-third of their nominal value.

Petroleum in Peru.—Attention is being drawn to the petroleum districts of Peru. The deposits are said to extend over wide areas. The geographical position of the petroleum fields of Peru is latitude 3° 25′ to 6° 5′ south, and longitude 81° 8′ 4″ to 3° 40′ west, which is almost on the same parallel with Australia, China, and other countries on the western border of the sea between them and Peru.

A New Standing Order Relating to Water Reservoirs.—Among some amendments to the Standing Orders of Parliament which came before the Houses for confirmation last week was one relating to the construction of reservoirs. It specified that, in cases where it is proposed to make, vary, extend, or enlarge any reservoir, the plan shall describe the embankment or retaining wall; and where it is the intention of the promoters of a Bill to apply for powers to make any lateral deviation from the line of such embankment or retaining wall, the limits of deviation are to be defined on the plan, and all lands included within these limits must be marked thereon.

THE IMPROVEMENT OF GAS-BURNERS.

THE "Murdoch Lecture" of Professor Vivian B. Lewes, which constituted such a striking feature of The Gas Institute meeting, has been heard of outside the hall of the Institution of Civil Engineers, and has formed the text of several more or less apposite moralizings and reflections in town and country newspapers. It has been a surprise to some of the writers upon this subject to learn that the application of coal gas to illuminating purposes is only a hundred years old, while others wonder at its having being known so long; for, judged by its record in discoveries and inventions, the last century has been longer than any thousand years that preceded it. For instance, there has appeared in the *Daily Telegraph*, a cloudy, pretentious article on the Murdoch Centenary which tells the reader that "wood and coal, when distilled in retorts, give off combustible exhalations;" but after retailing more information of the same vague character, the writer is good enough to express the opinion that, having regard to "the value of artificial gas, and its application to the thousand uses and necessities of daily life into which it now enters," the name of William Murdoch deserves to take place side by side with those of the greatest discoverers and inventors of the century. Of course, this writer finds it necessary to say that "it would be a bold prophet who asserted that, upon the second centenary of Murdoch's invention, gas would retain the commanding position it now occupies as an illuminant and motor." It may be observed upon this that not gas, but another means of lighting, is usually the subject of prophecy. Nobody can profess to know anything reliable of what the next hundred years may be expected to bring forth; and, therefore, the less said about matters at such a long range, the better. Those practical workers and philosophical theorists who are interested in gas, at any rate, prefer to take shorter views, and to attend to problems nearer at hand than that of artificial lighting a century hence.

This consideration brings us to a thought which, arising out of Professor Lewes's recent remarks, and also out of experimental work now in progress in other hands, reinforces the impression that many observers must have already received, that, instead of lighting by combustion methods being a thing of the past, the world is only beginning to learn how the light of this order of sources is really produced. Professor Lewes had much to say about the cause, or causes, of the luminosity of flames, especially flames of coal gas; and just before these statements were made public, Mr. Ludwig Mond had shown, by some striking experiments with nickelized carbonic oxide, how the Davy hypothesis respecting the cause of the luminosity of flames is borne out by the behaviour of ignited nickel carbonyl. These things are suggestive; and the lessons to be drawn from them bear directly upon the most immediate solicitude of the worker in gas lighting, which is, to obtain the highest possible illuminating effect from ordinary coal gas by simple means. As Professor Lewes has stated the problem, it is merely that of the improvement of the popular flat-flame burner—the burner of the people—which, whether in church, market-place, or home, is responsible for by far the greatest bulk of the gas burnt for lighting purposes in the world. We, however, do not confine the question to this. It is possible that the flat-flame burner may be improved by more intelligent treatment in the light of the principles enunciated by Professor Lewes in his Murdoch Lecture. It is nevertheless not to be taken for granted that this burner is the only thing of the kind that can ever become popular. If a short tulip-shaped or globular flame could be obtained by simple means, without the troublesome addition of a chimney, it might become even a greater favourite than the union-jet. Only it is essential that the new-fashioned appliance should give a briskly-burning, steady flame. There is much to be said for the kind of flame of which the "Lucigen" type of high-power lamps supplies the example—a flame of equal radiation in all directions, and not liable to be blown out. A gas-burner of moderate intensity which should give a flame of this character, and silent withal, would be a great acquisition.

It was good of Professor Lewes to mention the once well-known platinum "perfecter" burners, for these deceiving little arrangements, with their promise of economical lighting which was never long maintained, embodied a principle which has hitherto rested in obscurity. If the lecturer had desired to enlarge upon the history of mechanical or physical attempts to improve the luminosity of burning coal gas, he might have mentioned other devices besides that of Scholl. A very instructive example of such appliances was a burner which had below the point of ignition a chamber intended to contain a store of lampblack; the idea being that if it is carbon in a fine state of subdivision which constitutes the illuminating quality of coal-gas flames, an extra supply of carbon dust carried into the flame by the current of gas must improve the luminosity. As a matter of fact, the result was not according to the expectation of the inventor of the device. The current of gas betrayed a disappointing reluctance to take up any discoverable proportion of carbon particles from the store of lampblack through which it rose to the burner; and when impatiently tapped, in the same spirit that instigates to the tapping of a barometer which fails to move in accordance with the observer's wishes, the effect was merely to fill the flame with red specks, as of burning dust.

This example, like that of the failure of added acetylene to improve the luminosity of a flame of which it is (when naturally produced in it) the prime cause of the resulting light, shows how Nature resents the action of those who, inspired with a little knowledge, would make short cuts through her domain, and take her hidden benefits by storm. We may satisfy ourselves, by chilling a luminous gas-flame, and so getting solid carbon out of it, that it is solid carbon which imparts to the flame the luminosity of which we stand in need; but we cannot reverse the operation. The illuminating power of a coal-gas flame may be due to the presence, in a nascent stage, of acetylene; but with a separate store of acetylene and a non-luminous gas, we can do nothing. Not in our way, but in Nature's, must we work, if we would solve these riddles. However roundabout the course may appear to our narrow perception and impatient desire, the way of Nature is the only path that leads anywhere in these investigations; and the remarkable character of this route is that on either hand lie all manner of incidental surprises, so that, even if the persevering and observant traveller never reaches his journey's end, he may pick up something on the road more valuable perhaps than the reward he originally sought.

Granting we certainly know that carbon particles are the source of luminosity of flames, it is a crude suggestion that the simplest form of carbon in powder that we have at our disposal should serve to enhance this luminosity when injected mechanically into a flame. The suggestion supposes, in the first place, that the carbon particles formed and consumed in a flame are of the same dimensions and character as the lamp-black which we can get from the flame by interfering with its processes. There is, however, no good justification for this assumption, which is, moreover, disproved by the result of acting upon it. If the nascent carbon of luminous flames was in particles like those of lampblack, then the two might be interchangeable; but the fact that the particles of the latter, minute as they are, burn in flames like red specks of any other heavy kind of dust, whereas the former in the same place attain a high degree of incandescence, shows that these must be transcendantly small. In order to dimly understand the office fulfilled by nascent solid particles of carbon in a luminous flame, it is therefore necessary to realize the fact that these must be extremely minute—perhaps the very smallest things in the way of solids of which we can have any knowledge. The particles of lampblack are very minute, as has been found by observing their great effect in tinting solutions; but we cannot get them separated sufficiently to burn completely, as the nascent carbon particles do, in the course of their transit through the luminous part of a flame.

The problem of the improvement of gas-flames is the problem of burning the nascent carbon particles to better advantage, or supplying their place with something even more radiant at the temperature afforded by the flame. The regenerative burner does the former to the extent of about 25 per cent., measured upon the spherical distribution of the light. The limit of the capability of the heat-recuperation of gas-flames in this regard has been reached, having respect to the practical limitations of apparatus. To the question whether anything can replace or supplement the luminous carbon of free-burning flames, no conclusive answer can be given. The experimental success of the Clamond and Welsbach burners indicates the existence of unexplored possibilities in this direction, taking the carbon substitute in the solid form of an incandescent cap or mantle. Mr. Ludwig Mond's experiment with nickel carbonyl goes to show that means may be found for charging a gas with a metallic compound which shall resume the solid form in the process of combustion and so radiate light, which may be more or less brilliant than that radiated in similar circumstances from nascent carbon. In the latter line of research, it is important to take account of the products of combustion; for a bright light might be dearly purchased at the cost of polluting the atmosphere with something worse than carbonic acid. Are there any earths, unalterable by exposure to the heat of an atmospheric gas-flame, which become, under such conditions, more brightly incandescent than carbon, and are not so fragile when mounted for use as the Welsbach preparations; or is there anything of the sort which can be introduced into a current of coal gas, and be perfectly and innocuously consumed in the open air? This, as it seems to an observer, is the line which research into the development of light from coal gas must take in the immediate future. The prospects of gas as an economical illuminant do not altogether depend upon the successful solution of the problem herein discussed; but they would be immensely enhanced by a triumph in this new and most attractive region for experiment.

It is a peculiar characteristic of researches into the principles and methods of burning gas for illuminating purposes, that anyone possessed of a supply of gas and a photometer can engage in them. Very little apparatus of an expensive nature is required; and the labour incidental to the pursuit is no more than can be given by a gas engineering student in his spare time.

Professor Emil Fischer, of Würzburg, has been appointed to the Chair of Chemistry in the University of Berlin, in succession to the late Professor Hofmann, whose death was announced in the JOURNAL a few weeks ago.

NOTES.

A New Decorative Building Material.

A good deal of attention is being paid to a peculiar kind of building material termed "staff," which is largely employed for the external and internal finishing off of the principal structures intended for the Chicago Exhibition. It is not an American invention—having been brought into notice in connection with the Paris Exhibition buildings of 1889; but it has been largely employed in the provinces of Germany for the last fifty years. Its chief recommendation to engineers consists in the fact that it adapts itself very readily to combination with iron framework, and is possessed of respectable lasting qualities. The ingredients required for the fabrication of "staff" are simply plaster of Paris, hemp fibre, and water. Hemp is used to bind together and so strengthen the cast—the New Zealand fibre being preferred. The plaster for the "staff" is thoroughly stirred in water, and the hemp, cut into lengths of 6 or 8 inches, is bunched loosely, saturated with the plaster, and put into the moulds in a layer about 1 inch thick. More hemp is added until the mould is full, when the mixture is allowed to set, and is then withdrawn. The advantage of the "staff" is that, as moulded, it can be nailed to wood or screwed to iron; thereby imparting an appearance of solidity to, as well as protecting from the weather, light structures that would otherwise look naked and bare. It also furnishes a cheap and easy way of applying decoration to coke-breeze houses, &c., which, in the absence of some such material, appear very flat and crude.

The Metallic Carbonyls.

Mr. Ludwig Mond recently brought the subject of metallic carbonyls before the Royal Institution. In the course of his lecture, Mr. Mond pointed out that the nature of carbonic oxide, as a chemical radical, was made known by Justus Liebig so long ago as 1834; but it was only two years ago that the lecturer, in conjunction with Drs. Langan and Quincke, was able to announce the successful preparation of a compound of carbonic oxide with nickel, which is not only a well-defined compound, but possesses remarkable properties. Mr. Mond showed his audience how a highly luminous flame may be obtained by passing a slow current of carbonic oxide through a gently-heated tube containing metallic nickel in a state of fine division. The luminous effect was due to incandescent particles of metallic nickel separated in the body of the flame from nickel carbonyl. When the nickel carbonyl is caused to impinge upon any solid heated to only 200° C., the result is a deposition of bright metallic nickel; and carbonic oxide is liberated. The analogy with the deposition of soot from a flame of hydrocarbon gas is obvious. Again, Mr. Mond passed the nickel carbonyl through a tube surrounded by a freezing mixture, and condensed the compound into the visible form of a clear colourless fluid. A mixture of the vapour with air explodes readily, but not with violence. The vapour of nickel carbonyl possesses a characteristic odour, and is poisonous; but not more so than carbonic oxide gas—which, indeed, it could hardly be. Professors Dewar and Liveing are investigating its absorption and flame spectra. They have found that it is opaque for all the rays beyond the wave-length 3820. Its flame gives a quite continuous spectrum. Within a short time after the existence of iron carbonyl had been made known, Sir H. Roscoe found it in carbonic oxide which had been stored in an iron cylinder; and he expressed the opinion that it is the cause of the red deposit sometimes found upon steatite gas-burners. The industrial future of the carbonyls, particularly nickel carbonyl, is expected to be very wide, and advantageous in many ways.

German Coke-Oven Residuals.

Herr Fritz W. Lürmann, of Osnabruck, has reported to the Society of German Ironmasters on the position and prospects of residual-recovering coke-ovens in Germany. He stated that this new branch of industry has developed notably during the last ten years, especially on the Continent. Efforts to recover the bye-products of coke manufacture have been viewed with considerable suspicion, which even to-day has not been wholly dissipated. Doctor Otto and Herr Hüssener were the pioneers of this industry in Germany; building a number of Hoffman-Otto ovens on their own account as well as for different mines and factories. At present the firm of Dr. C. Otto and Co., of Dahlhausen, contract to erect a set of 60 ovens, with all appliances for the recovery of bye-products, for 720,000 marks, of which the ovens stand for 300,000 marks. Such a set produces annually about 50,000 tons of coke, from 2000 to 3000 tons of tar, and from 500 to 800 tons of sulphate of ammonia, according to the coal used. The Semet-Solvay is another popular description of the same class of coke-oven; and the Coppée plant for the same purpose is also being introduced into Germany. Three years ago the first steps were taken for the recovery of benzol from coke-oven gases. Herr Franz Brunck, of Dortmund, is the inventor of the process used for this purpose, which is kept as a trade secret. It is claimed that from 3 to 7 kilogrammes of benzol are obtained per ton of coal coked. Notwithstanding the low values ruling for tar and sulphate, the coke makers manage to do well with their residuals-recovery processes, and hope for better times as the demand for tar by the briquette-fuel manufacturers increases. The field for sulphate is practically limitless; for of the total nitrogen contents of the fertilizers sold last year, which amounted to nearly 57,000 tons, only the equivalent of 6800 tons was in the form of sulphate. It cannot be fairly assumed that all this class of fertilizers—the nitrogenous—can be supplanted by sulphate of ammonia, because the latter does not, under all circumstances, serve the purpose as well as nitrate or guano. If this were the case, however, 185,000 tons of sulphate per annum would be required in Germany; whereas at present only 17,500 tons are recovered from coke-ovens, and all the coal coked in Germany would not yield more than 120,000 tons.

COMMUNICATED ARTICLE.

GAS WASTED AT GAS-WORKS.

By Norton H. Humphrys, Assoc.M.Inst.C.E., F.C.S.

I have been interested in reading the article, on "Gas Consumed in Works and Offices," appearing in the JOURNAL for the 10th ult., in which the writer directs attention to the large quantity of gas consumed, or estimated to have been consumed, on the ordinary gas-works. Some years ago, I was struck with the magnitude of this item, and gave some attention to the quantity of gas actually necessary for the operations of gas manufacture. But before making any deductions from the published reports, it is necessary to inquire in how many works the quantity said to be consumed is actually ascertained by meter. Is it not the common practice to estimate this quantity by simple guesswork? And further, is it very unusual to take care that the estimate is a liberal one, in order that the unaccounted-for gas may appear as low as possible? There is a story told of a manager of a business (not a gas-works) who produced his books to the accountant in order that the latter might prepare the official balance-sheet for the year. "I see," said the man of figures, "that you have not put down your stocks on hand at the end of the year. I must have them before I can prepare the accounts." But the manager replied: "You tell me the balance available for profit, and then I will tell you the value of the stocks." Is it not the case that the gas-works manager sometimes says, "You tell me the total difference between the quantity of gas sent out and that actually paid for, and then I will tell you the quantity of gas used in the works?"

So, before proceeding to make a few suggestions on this subject, I wish to insist strongly on the importance of passing all the gas used on the gas-works through a meter or meters, so that if any waste is going on, it may actually be proved from fact. The cost of maintaining a meter (or three or four, if necessary) will be well repaid by the gas saved, when it is known that attention is being directed to the quantity actually used. For it must be remembered that, after every possible care has been taken, the gas-works will remain a large consumer. The retort-house and other parts of the works must be lit up throughout all the hours of darkness—some 4300 hours per annum. Any waste due to defective or extravagant burners is, therefore, greatly accentuated, as compared with gas used on the premises of an ordinary consumer, between the hours of dusk and 9 or 10 o'clock at night. If it is important for a gas consumer to have thoroughly good burners, to be used for perhaps an average of four hours a day, how much more is it so when the burner is to be used for ten or twelve hours?

Of course, this will be met by the argument that a gas company does not pay for its own gas at retail price; and that there is no cost for distribution or office expenses as regards the gas used on the works. But it must be remembered that the gas so consumed costs just as much to put into the holder as that actually sent out; and, therefore, its cost to the company may be taken as the same as the cost delivered into the holder. This is easily (or should be easily) ascertainable from the accounts; and it may be taken at about 2s. per 1000 cubic feet under ordinary circumstances. Even putting it as low as 1s. 6d., there is room for using it in the most economical manner. At present prices of coal and labour, no gas engineer can allow even a pound's worth of coal, lime, or sundries out of the stores to be wasted; and a pound saved in the consumption of gas is a pound added to the balance available for profit, quite as surely as if it had been earned in any other way.

It is no common thing, in a small country gas-works making (say) two millions per annum, to leave a large batswing burner full on in the retort-house throughout all the hours of darkness, and occasionally in the daylight, or possibly never put out at all, but only turned down in the daytime. Such a burner, consuming 10 cubic feet per hour, would get rid of 40,000 to 50,000 cubic feet of gas per annum—2 to 2½ per cent. of the total make—or an actual money cost to the company of £6 or £7. Here, then, is room for an economy equal to a reduction of 1s. or 1s. 6d. per week in the wages of the stoker, which would probably be considered a matter of some importance by the directors, if put in the light. During a considerable part of the year the burner need not be lit at all, and might be used in connection with a pilot jet for the remainder; being only turned up during the time that it is actually required. Go to a larger works, and frequently the same thing is repeated on a corresponding scale. The whole of the retort-house is brilliantly lit up by means of large batswing burners during

the whole term of darkness, although the time during which it is tenanted by workmen is only one-half.

Some years ago I had to do with a small gas-works making about 6 millions per annum. It was usual to put down the gas used on the works as a quarter of a million feet in each year; the gas being burned away direct from a service off the outlet main in the usual manner. By way of an experiment, the works' supply was completely metered—a 10-light meter being fixed for the retort-house, coal-shed, and lamp outside, with a 3-light meter for the meter-house, and a 5-light one for the offices. The latter two included gas-heating stoves. The total consumption indicated by the three meters for the first year was about 280,000 cubic feet, of which more than 200,000 cubic feet went through the 10-light meter, which supplied four batswing burners. This illustrated first the importance of checking the pressure, and secondly of periodical attention to the burners; and I think these two matters indicate a remedy for a large proportion of the gas wasted on gas-works. By attending to them in this case, the total consumption was reduced to less than 200,000 cubic feet; and it has since averaged about 180,000 cubic feet per annum. Here there is a clear saving of 100,000 cubic feet of gas, representing at least £12 in money, secured by the use of three gas-meters and a little occasional attention. The cost of the meters was saved in the second year of use alone. The manager of that gas-works would think that he did well if a saving of £10 on the cost of the lime used was secured.

For naked burners fitted in the retort-house itself, nothing better than ordinary iron batswings can be used, on account of the dust, smoke, and draught; and they must be burned at a good pressure, to keep the flame steady. But the pressure need not be excessive; and the burners may be frequently cleaned or renewed. This, however, only applies to the retort-house. There is no reason why the most modern improvements in the way of gas-lighting should not be introduced in the exhauster house, the meter and governor houses, and the lamps in the yard. Yet somehow, the iron batswing seems to reign supreme in these places, and even in the offices also. And this notwithstanding the fact that, in addition to the advantages already pointed out, it would pay to use the best burners. In one instance, three regenerative burners, consuming 11 cubic feet per hour each, replaced ten batswing and union-jet burners, which flared away more than twice as much gas. Not only was there a substantial saving of gas, but a much better lighting effect; and the lights were available for use as an advertisement. At the same time, the company's gasfitter was able to acquire practical experience in the working of the new burners, which has since proved of immense value in the district.

At many of our railway stations, a bye-pass tap is used on the main supply from the platform; and it is so placed that the platform inspector can conveniently turn the lights down to a glimmer between the trains. As soon as a train is signalled, he turns up the lights; and as soon as the platform is again clear he turns them down again. Something of this kind might be adopted in the retort-house, the exhauster-house, and indeed every other room in which gas is used. The tap could be arranged in a convenient position, close to the entrance door, and turned up when the man enters, and reduced again when he leaves. In small works, the foreman stoker visits the exhauster room for a few minutes, perhaps once in an hour, and the meter house for a similar short period, throughout the night. The aggregate time he spends in these places would not be an hour throughout the shift. Why should one or two large burners be continually flaring away in each room? So with the men's mess rooms and offices. Nobody thinks of turning the lights down when the rooms are left.

To every gas manager who is looking round for ways and means of ecomony in regard to working expenses, I suggest that the means above noted, if nothing has already been done, afford fair ground for working that is not to be despised. First find out how much gas is really being used; then see that none is burnt at excessive pressure, or through unsuitable burners; and lastly, see that the gas is not burning at times when it is not required.

Mr. D. Ford Goddard.—In our editorial columns to-day, reference is made to the candidature of Mr. D. Ford Goddard for a seat in the new Parliament, to represent Ipswich, the town with which he and his family have been so long associated, from their connection with the gas undertaking. Before going to the electors, however, he resigned his office of Mayor, in accordance with the understanding come to when he took it last November, that he would have to relinquish it in the event of a General Election. This he formally did at the meeting of the Town Council on the 17th inst.; at the same time paying the fine of £50 imposed by law. The new Mayor (Alderman Cowell) proposed a vote of thanks to Mr. Goddard for the able manner in which he had discharged the duties of the office, and for the generous hospitality he had displayed during his tenure of it. In acknowledging the compliment, Mr. Goddard said the enjoyment he had experienced in the seven months of his mayoralty had been largely heightened by the uniform kindness and courtesy shown to him by all the members of the Council, and indeed by everyone in the town. In conclusion, he asked to be permitted to add his portrait to the gallery of Mayors in the library of the Town Hall.

TECHNICAL RECORD.

TESTING THE ILLUMINATING POWER OF COAL GAS.

At a Recent Meeting of the Manchester Section of the Society of Chemical Industry, Mr. GEORGE E. DAVIS, F.I.C., read a paper on the above subject.

The author began by remarking that as a Committee was now sitting, having for its object an inquiry into the subject of a standard for photometric purposes—the sperm candle not having for a long period been considered satisfactory—he could not enter into a discussion upon the matter of a standard light; but there were many other points open to consideration, such as contrasting the basis upon which physical tests were made with that upon which chemical examinations were founded. He went on to say it might be taken for granted that, if coal gas was always of the same quality, there would be no need for a trial to be made of its illuminating power. But it was not a simple gas, as it consisted in a great measure of non-illuminating hydrogen and feebly illuminating marsh gas made luminous by partial saturation with the vapours of benzol, toluol, crotonylene, and other hydrocarbons, the excess of which were found in the tar which was condensed from the crude gas. The gases further did not come off from the coal in regular and even proportions; the composition of the gases given off during the first half of the period of carbonization yielding greater luminosity than those given off during the latter half—in fact, towards the end of the charge, little else than pure hydrogen was given off, having very small, if any, luminosity when burned. He was fully aware that the gas leaving the hydraulic main in a well-regulated gas-works was of fairly constant composition—its illuminating power would vary in different works, according to the length of time (and the temperature) the gas was allowed to remain in contact with the tar; and this was brought about by the regular and alternate system of charging the retorts. But it was possible that a variation of quality from this source might have to be considered in the future, as it would be quite easy to arrange the charging so that gas of 20-candle power could be collected from the anterior portion of the charge, and gas of 10-candle power from the posterior.

It was next pointed out by Mr. Davis that the quantity of gas yielded per ton of coal affected the illuminating power (as might be learnt by studying the paper read before the London Section of the Society, in 1884, by Mr. Lewis T. Wright).* In the gas-works he was instrumental in establishing near Sheffield, it was his aim to secure a large quantity of illuminants; and as the result of many experiments, working the same quality of best fresh-wrought gas coal, he obtained 9060 cubic feet of 18-candle gas per ton, 10,100 feet of 16-candle gas, or 11,400 feet of 14-candle gas. In the first case the coke was too soft for sale; and in the last case it was hard and saleable. The tendency was nowadays to run the production up to the highest possible limit; and without more benzol was volatilized from the tar than formerly, the result would be a debased gas. There was also another reason why coal gas should have trial made of its illuminating properties. A process was introduced some years ago, better known perhaps as the Hawkins process, for introducing carburetted air into the gas before the oxide purifiers, in order to prevent the necessity of so frequently changing the contents. The oxygen of the air introduced acted upon the sulphuretted hydrogen in the presence of oxide of iron, forming water and free sulphur, while the nitrogen remained in the gas, diluting its illuminating power.

Directing attention to the apparatus used for testing gas and the regulators governing its use, the author remarked that, though the Gas Acts were so stringent with respect to the testing of meters, there were at present no compulsory powers for the public testing of photometers. A photometer might be perfectly accurate when first purchased, but a disarrangement or displacement of the scale, the candle-balance, or the standard burner, was quite enough to give the most fallacious results; and there was no compulsory provision for verifying these instruments. The suppliers of coal gas could legally object to the use of any other apparatus than that specified; but this, of course, made no difference whatever in the accuracy of the results. In fact, various details of photometry had been greatly perfected since 1871; and he doubted, if a Gas-Works Clauses Amendment Act were passed to-morrow, whether the apparatus and methods would be the same as specified in the Act of 1871.

The photometer used by the author was designed not only for examining ordinary coal gas, but for all-round uses, one of which was a thorough examination of the illuminating power yielded by the vapours of different hydrocarbons. This instrument might be called a 60-inch enclosed "Evans;" but it differed from the "Evans" in that the scale was divided into inches and tenths, instead of being graduated for "candles." This made a calculation necessary for each experiment; but as a table had been calculated for each possible position of the screen index, a simple inspection of it gave the candle power direct. The apparatus was fitted with an experimental meter, reading to the one-hundredth of a cubic foot; it was also fitted to burn either the prescribed pair of sperm candles, or a 10-candle Methven light prepared with great care for him by Messrs. Sugg

* See JOURNAL, Vol. XLIII., p. 535.

and Co. The gas to be tested was burned in one of Sugg's "London" Argands as prescribed. Nearly 1000 tests of Salford gas had been made with the apparatus. The reason a 10-candle standard was adopted was, first, because it was a very convenient standard having regard to the experiments in which he was engaged; secondly, because the screen was thus brought nearer the centre of the graduated bar, thus ensuring greater accuracy than when a 2-candle standard was employed; and, thirdly, there would only be the same absolute error in adjusting a 10-candle standard as in making a 2-candle standard, in which latter case the error (if any) was five times greater than with the 10-candle standard. This 10-candle standard was presumably made and standardized with London gas. When tested with Salford gas against sperm candles burning 120 grains of sperm per hour, it yielded a light of 9·94 candles. Thirty separate tests were made to establish this, according to the directions given for testing gas by the Gas Referees. Of these tests, five were rejected owing to the abnormal rate of consumption (being below 144 or over 126 grains); while if the ten nearest tests to 120 grains were taken, the illuminating power came out exactly 10 candles.

When the testing was first established, Mr. Davis was surprised at the low results; and having satisfied himself that the 10-candle standard was absolutely correct, he carefully examined every point in detail, without finding any error. The testing was continued in this manner for something like three months; the average value coming out at about 15·7 candles. The apparatus was then altered by the substitution of a pair of sperm candles for the 10-candle Methven standard, and tests were made twice a day for upwards of three months. The average in this case worked out at 15·4 candles. The nuisance of using candles in place of the Methven standard was so obvious in these experiments, that they were abandoned; and, in continuing the experiments, the Methven standard was alone employed, and further experience had shown it was far more reliable than the candle, and much more convenient to use.

A few words as to the consumption of sperm in nearly 1000 tests the author thought would not be out of place. The consumption was most irregular, varying from 108 grains on the one hand to 137 grains on the other. The Gas Referees having prescribed that all tests in which less than 114 grains, or more than 126 grains were consumed should be discarded, this was done in all these tests; the proportion being 15 per cent. The tests retained, in which less than 118, or more than 122 grains were burnt, amounted to 55 per cent.; while the tests burning from 118 to 122 grains amounted to the remainder of 30 per cent. This was the boasted parliamentary standard; and, to do it as much justice as possible, the author stated that the candles were from a recognized leading maker. His experience in photometry led him to say most emphatically that the parliamentary "candle" was by no means a *standard* that analytical chemists would be satisfied with—it might suit gas engineers, but not a chemist with any idea of accuracy.

This led him to another point. Coal gas was usually tested at the gas-works, which, in his opinion, was a most unjust provision of the law. Consumers did not burn the gas at the gas-works, and sometimes there was a great difference between tests made in the works and those made half a mile away. His own tests were cases in point. Taking the Salford supply to his laboratory, on July 2 last year, the gas tested by his photometer (day supply) was 13·4 candles; on Nov. 16, 13·2 candles; Dec. 5, 13·6 candles; Dec. 22, 13·1 candles; Dec. 23, 12·3 candles; and Dec. 24, 12·5 candles. The two last tests were made during the very foggy Christmas week, when gas was being burned all day long, and when the consumers were complaining to each other very generally that "the gas was very bad."

The following is a summary of the whole of Mr. Davis's tests from July 1, 1891, to Feb. 27, 1892:—

Month.	Illuminating Power. Candles.	Grains of Sulphur per 100 Cub. Ft.	Carbonic Acid. Vols. per Cent.
July, 1891	14·70	16·81	0·56
August, 1891	14·34	14·60	1·22
September, 1891	14·40	17·12	1·14
October, 1891	15·20	20·01	1·13
November, 1891	15·16	21·92	1·05
December, 1891	14·72	24·88	0·98
January, 1892	15·09	19·07	1·12
February, 1892	14·75	19·86	1·07

The results of these examinations did not agree with the tests made at the gas-works; but why, the author did not pretend to explain. He convinced himself, however, that the readings of his photometer were accurate. The Salford Gas Committee said that the tests made by them (in the works) averaged, for 1891, 18·86 candles at one works, and 18·71 candles at another station. This was very poor consolation for those who had to burn the gas a mile away from the works; and he was of opinion that the subject was important enough for the Council to investigate over the heads of the Gas Committee. He also hoped that our legislators would consider whether the time had not arrived when testing-stations should be removed from the precincts of the producing works to some public office at a distance. Such a process would undoubtedly be more assuring to the consumer than the present system; and if the results should turn out identical with those obtained at the works, those in charge would not complain, while, if the results differed, the sooner the cause of it was discovered and remedied, the better for all concerned.

One thing struck Mr. Davis during these experiments; and that was the ease with which a special standard for each gas supply might be made and verified. It was simple, though somewhat tedious, to make a large number of tests with sperm candles, rejecting (say) all under 118 grains and all over 122 grains consumption. A Methven screen could thus be cut with very great accuracy; and this could be made of the minimum power the works were allowed to supply. Such a standard should not be put into use before verification by the Standards Department of the Board of Trade; and reverification should be made compulsory every six or twelve months, under heavy penalties for disobedience. At present he was not aware that the verification of photometers was compulsory; and referring to the serious differences between the results obtained with his photometer and that of the Salford Gas Committee, he asked whether they might not be due to the employment of an unverified photometer at the works. The Gas Act was faulty in many respects; and now that he had given the results of his experience, the author hoped the matter would be taken up, and the testing of coal gas for its illuminating power be put on a proper basis.

In the course of the discussion which ensued, Mr. Carter Bell said he had made some experiments with Mr. Davis's photometer, and he was bound to admit that the 10-candle standard as used by him and his method of graduation of the beam was an immense improvement on the ordinary method of testing coal gas; and he believed far more accurate than the photometer mentioned in the Act of Parliament. Dr. Grossman remarked that the difference in the illuminating power of gas, as shown by the photometer at the gas-works and by the time it reached the consumers, might be accounted for by the hydrocarbons deposited in the mains; but, in his opinion, the consumers had nothing to do with this, as gas companies and corporations should be compelled by their Act of Parliament to supply gas of a certain standard to all their consumers, however far they might be situated from the works. Dr. Dreyfus thought that, as gas contained certain hydrocarbons which produced the illuminating power, it was a question whether it could not be more accurately tested by chemical analysis than by the ordinary means of photometry. Dr. Carl Weber was afraid that the relation existing between the hydrocarbons and their illuminating powers was so complicated and exceedingly difficult of interpretation, that the photometric test was the best test of the illuminating power of gas, and that chemical analysis was not admissible. Mr. Stenhouse said it was generally acknowledged that the best time for making a test was during the night, when the largest consumption was taking place; but Mr. Davis's experiments seemed to have been made during the day. Dr. Bowman observed that it was usually considered that greater condensation took place in the daytime than at night, when the gas was more agitated by the increased consumption going on. He had found as much as 5 candles difference between noon and night. He was quite convinced, from experiments which he had made, that the mechanical means of testing were much better than any chemical method could ever hope to be. Mr. Wilson said that when, in consequence of complaints which had been made by consumers at Bury, the Gas Committee established a photometer some distance from the works, serious differences were found between the quality of the gas at the works and the testing-station; and this difference was at the time attributed to condensation. Dr. Bailey wished to call attention to a fact which might have been overlooked, and that was that very frequently low results were obtained simply through air having got into the pipes, and the gas not being allowed to burn before the test was made. Mr. Davis, in reply, said he did not consider that condensation in the mains was at all a serious matter. If condensation kept taking place, the condensed liquid should appear in the street syphons, where it was well known that nothing but foul water usually appeared. A deposit of hydrocarbon from the gas could only take place if the gas were saturated with hydrocarbon vapours; and he had never yet met with a sample of gas thoroughly saturated. He was also of opinion that the physical test of photometry was far more reliable than it was possible to make any chemical test. If the argument were a valid one, that hydrocarbons were deposited in the mains during the slow flow of gas, and taken up again in the equal rush by night, the candles lost in the daytime should increase the luminosity of the gas in the evening. He had never found such an increase, although there was a difference between the day and the night quality; but this was due to the greater percentage of nitrogen in the daytime than at night.

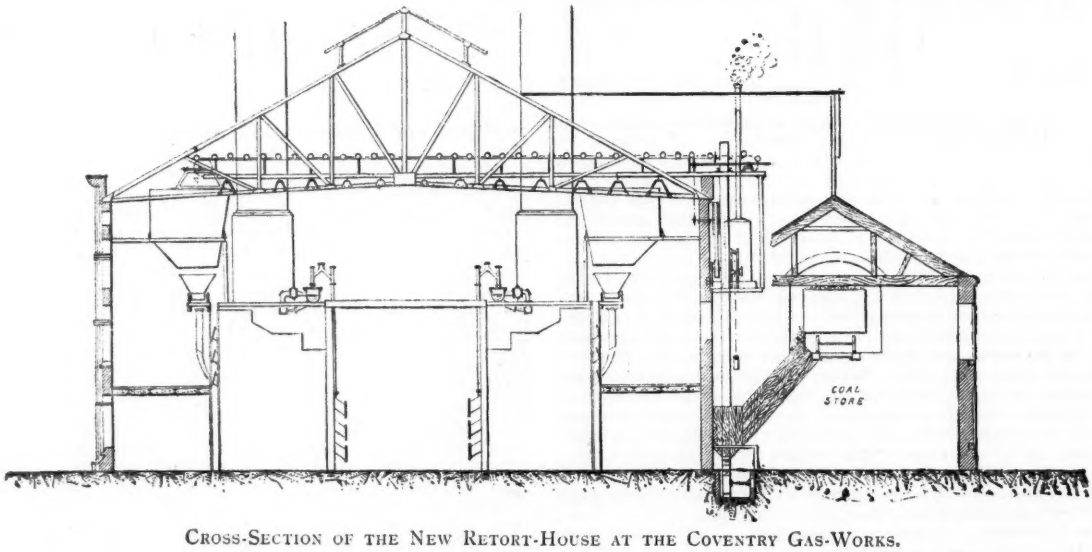
Association of Municipal and County Engineers.—A meeting of this Association (of which Mr. T. Cole, Assoc.M.Inst.C.E., Secretary of the Incorporated Institution of Gas Engineers, is the Secretary), was held at Scarborough on the 18th inst., under the presidency of Mr. T. de Courcy Meade, of Hornsey. Mr. G. Ball, of the Borough Surveyor's office, read a paper by the Surveyor (Mr. J. Petch) on "Scarborough—Its Progress and its Public Works in Recent Years;" and the Water Engineer (Mr. W. Millhouse) read another, describing the works under his control.

AN AUTOMATIC RETORT-HOUSE AND COAL-STORE.

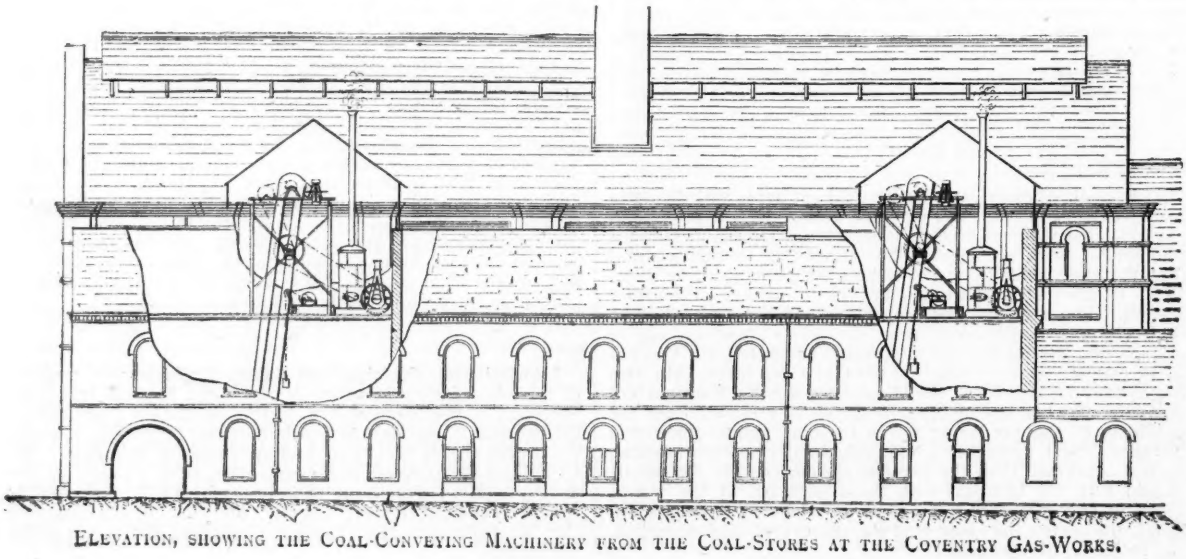
It is a matter of common knowledge that every industry is occasionally visited with an outbreak of inventiveness on the part of those who are engaged in it. The gas industry is just now in this position; for it may be safely stated that, among gas engineers and managers there is, at present, almost a universal desire for improvement and economy in the retort-house. Their chief object is to obtain machinery to supersede the human hand, and, in the severe work of charging and drawing retorts, make the men merely attendants on appliances which produce results superior to their own. Our readers are familiar with the special activity which during recent years has been directed to the solution of the problem of the automatic charging and discharging of retorts, and the mechanical manipulation of the coal and coke by means of conveyors and elevators. But the accompanying illustrations of the new retort-house at the Coventry Corporation Gas-Works, designed and erected by Mr. Winstanley, with the feeding shoots to the inclined retorts fitted under the patents of the Automatic Coal-Gas Retort Company, Limited, and equipped throughout with conveyors and elevators by the New Conveyor Company, is perhaps one of the most complete automatic arrangements at present in operation in this country.

The retort-house buildings and the installation of the retorts were designed and carried out in every detail by Mr. George Winstanley, Assoc.M.Inst.C.E., Gas Engineer to the Coventry Corporation, for a special arrangement of twelve settings on either side, with the coal-stores running parallel with the benches on one side. Prior to setting out the new house, Mr. Winstanley carried out a series of exhaustive tests, on an experimental setting of six inclined Ω retorts, each 21 in. by 15 in., and 15 feet long. During the tests with the trial setting, Mr. Winstanley made many changes, and tried various heats; and he eventually satisfied himself that, however the retort might buckle in the heating, the even distribution of the coal and the free running out of the coke were effected without the drawbacks and the manual attention required in some of the prior tests made on inclined retorts at other works. This success was in a large measure due to the fact that the regenerative arrangement of heating adopted in the experimental setting was Mr. Winstanley's own patent system; and the advantages gained were that only 10 lbs. of coke were used per 100 lbs. of coal carbonized, and a uniform distribution of heat was obtained throughout the entire setting at a very high temperature. These advantages enabled Mr. Winstanley, during the trials, to carbonize 7 cwt. of coal every six hours; being 28 cwt. per retort per day, or 8 tons 8 cwt. per bench of six. With such results as these, it cannot be matter for surprise that Mr. Winstanley immediately decided to have the new house (which is shown in section in fig. 1 of the accompanying illustrations) fitted throughout with inclined retorts. The buildings are exceptionally handsome for a retort-house, and—a point which we think of more importance—they are particularly wide and lofty; thereby ensuring perfect ventilation. The house, which is of red brick, is 74 feet span and 127 feet long. The roof is in one span—the principals being 20 feet apart; and the trussing adopted is composed chiefly of flat iron.

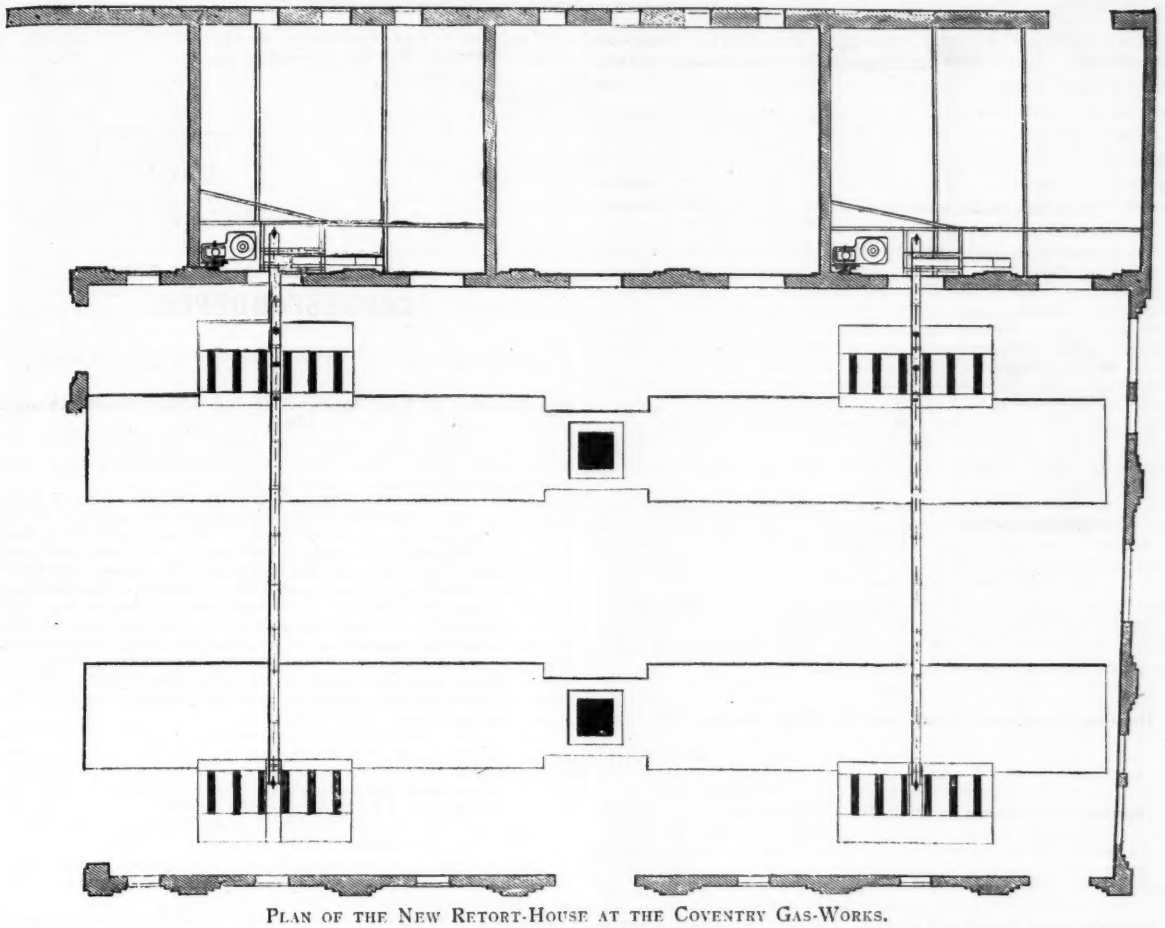
To enable our readers to clearly follow the illustrations, we now proceed to describe the manipulation of the coal, from the time it is shot from the waggon, as shown, into the receiving hoppers over the coal-crushers, until the coke is distributed automatically into the yard. Referring to the illustrations, it will be seen that a line of railway extends up the length of the coal-stores, in which two elevators are arranged with receiving hoppers, with coal-breakers fixed over the elevator boots. The coal is shot from the waggons into the hoppers, and is fed by the breakers into the elevators. The breakers are of very simple design, and suitable to regulate the feed of any size of coal. The elevators, which are of Mr. Gilbert Little's design, with flat and round steel links, and steel buckets enclosed in dustless steel casing, lift the coal to the two cross conveyors,



Cross-Section of the New Retort-House at the Coventry Gas-Works.



Elevation, showing the Coal-Conveying Machinery from the Coal-Stores at the Coventry Gas-Works.



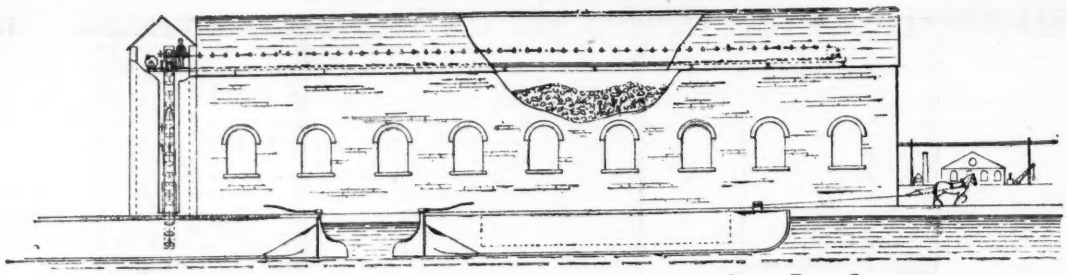
PLAN OF THE NEW RETORT-HOUSE AT THE COVENTRY GAS-WORKS.

which in turn deliver it into the four large storeage-tanks fixed at each corner of the house. The conveyors are also of Little's patent noiseless design, with steel troughs, and push-plates carried on guide-pulleys, so as to prevent the plates from touching the sides or bottom of the trough. The coal-tanks hold 40 tons each—being a sufficient quantity for the night supply; so that the machinery requires to be run during part of the day shift only. Both the elevators lift 15 tons per hour; and it will be seen from the illustrations that the engines, elevators, conveyors—in fact, the whole of the plant is duplicated, so that if one side is, from any cause, stopped, the entire retort-house can be supplied by the reserve machinery. The tanks are of special design, the sides being all of one steel plate, bent to position by heavy hydraulic machinery at the works of the New Conveyor Company. In the bottom of each tank are fitted six doors through which the coal passes to a portable charging tank, arranged to hold six charges of 8½ cwt. each. This tank was designed by Mr. Winstanley. It is moved along the rails by means of a chain and chain-wheel pulled from the charging-stage. The doors in the bottom of the portable tank are opened and closed from the same stage; so that the labourer charging the retorts has everything at his hand. Under the tank three steel shoots run on rails, and conduct the charges to the three tiers of retorts. As the coal falls down the retort, it is checked by a plate inserted a little way up the retort. This plate prevents the coal from running down to the discharge mouthpiece; and at the same time it forms a stop for the flow of coal, so that an even depth of coal is distributed over the complete length of the retort. Large pieces of coal, as well as the dust, are deposited evenly in the retort. The velocity of the flow of the coal as it falls from the portable tank through the moveable shoots is regulated by means of a weighted swing flap; and after the coal passes this flap-door, it is further regulated in flow by a check fixed on the delivery point of the shoot. In the charging mouthpiece is placed a shield, to give a smooth face for the coal to flow over into the retort.

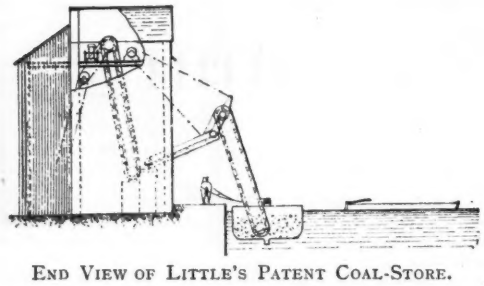
The charge having been put into the retort as described, the shoot is withdrawn, the mouthpiece with self-sealing lid is closed, and the portable tank moved to the next or any other setting; the whole operation of charging a retort not occupying more than five seconds by an ordinary labourer. When the coal is carbonized, which in this particular retort-house is done in about six hours, the lower mouthpiece is opened and the stop-plate removed; and the coke then slides out. The angle of the retorts varies from 30° to 31½° in the different tiers; the top range of retorts being, of course, at the greater angle, to compensate for the shorter fall from the portable coal-tank. At present the coke slides into a truck which holds a charge; but Mr. Winstanley has had plans prepared showing an arrangement of Little's patent endless steel-rope coke conveyors with an inner trough, travelling in a fixed jacketed water-trough. The hot coke falls direct from the retort on to the moving trough, and thus wear and buckling are prevented. Besides this, the quenching of the coke is partly effected, as it moves along through the water trough. In the extensive arrangement of patent conveyors for Mr. Winstanley, the coke is carried by them along the passage, where the clinkers are also removed. On reaching the end of the passage, or tunnel, the coke under the discharging stage is shot by the fixed conveyor into an elevator, which lifts it to a conveyor at a height of 30 to 40 feet, and distributes it all over the yard. Mr. Winstanley is also arranging coke-screening plant under the conveyor, so as to deliver different sizes of coke direct to the carts of buyers. The tunnels or passages in which the coke conveyors are fixed are 10 feet deep and 20 feet wide.

The system of heating used is, as already stated, Mr. Winstanley's own patent regenerative furnace, with modifications and improvements made by him to suit the inclined retorts; and it may be mentioned that Winstanley's patent furnace has been equally successful in connection with ordinary horizontal retorts. His system is also in use at the Droylesden works of the Manchester Corporation; and there is no doubt that the marked success of the inclined retorts at Coventry is in a large measure due to the effective heating arrangement. We are also informed by Mr. Winstanley that the difference in the pressure of the gas at the top and the bottom of the retort is very slight; but he prefers putting the ascension-pipes at the lower end. We believe the carbonizing is so perfect, that there is actually no trace of tar deposit in the mouthpieces.

In conjunction with the new retort-house at Coventry, we also illustrate an automatic coal-store designed specially by Mr. Gilbert Little, the Managing-Director of the New Conveyor Company, for gas-works situated on a canal or navigable river. But a similar arrangement has also been designed to suit the most varied methods of taking the coal from waggons to the stores. It will be seen from the illustrations, that the coal is lifted from the barges by an adjustable elevator. When this is not in use, it is lifted by the crab-winch, as shown, by a steel rope, and placed against the wall clear of the towing-path. The coal, as it is lifted by the elevator from the barge, is shot on to a special form of conveyor, fixed between the jibs. This shoots the coal into the stationary elevator fixed inside the coal-store, which in turn delivers it into the conveyor arranged in the roof, so as to trim the coal all over the floor to any desired height. The long conveyor, which extends the entire length of the coal-store, is of Mr. Little's patent steel-rope noiseless design. It will carry



ELEVATION OF LITTLE'S PATENT COAL STORE, WITH NOISELESS STEEL-ROPE CONVEYORS.



END VIEW OF LITTLE'S PATENT COAL-STORE.

coal, coke, oxide, or lime, any distance up to 1500 feet, and is made in sizes to carry from 2 to 200 tons per hour.

The accompanying illustrations are from drawings specially prepared for the JOURNAL by Mr. Little.

The Clay Lane Local Board and the Water-Works.—The Clay Lane Local Board having offered the Water Company £14,000 for their property, the Directors have had the matter under consideration, and have intimated that they will not accept less than £16,500. The Board, at their last meeting, resolved not to increase their offer.

The Use of Gas-Stoves in Bristol.—The Directors of the Bristol Gas Company have resolved to reduce, by nearly one-third, the rentals of the gas-stoves they let on hire. They also intend to make a charge of 5s. for fixing, instead of at the old rate of 4d. per foot for the piping used. At the present time about 2150 stoves and fires are rented by customers residing in the city; 350 having been fixed this year.

Swinton Local Board and the Gas Supply.—A special meeting of the Swinton and Pendlebury Local Board was held on Monday last week, when a report on the gas question was adopted. It was also unanimously resolved that a deputation should wait on the Salford Corporation with a view to ascertaining what concessions they were prepared to make in supplying gas to the district.

New Water-Works for Wakefield.—Last Thursday, the first sod of the new Withens reservoir, on the Rishworth Moors, in connection with the Wakefield new water-works scheme, was cut by Mr. J. S. Booth, the Chairman of the Corporation Water-Works Committee. A beautiful barrow and spade, with silver mountings, were presented to Mr. Booth by the contractor (Mr. T. Oliver, of Horsham, Kent). The cost of the works is estimated at £120,000.

North Shields Water Company.—The report of the Directors of this Company, to be submitted to the shareholders at their annual meeting next Thursday, states that, as the result of the adverse decision in the action brought against the Company on the question of the basis of charging water-rates, the revenue has decreased, although some portion of it has been recouped by an increase in the consumption. The gross revenue for the year has been £9968 19s. 6d.; and the expenditure £8949 16s. 10d. (including interest on loans, amount paid to the Newcastle and Gateshead Water Company, law costs in both the recent actions, and amount paid on account of the costs of the Bill in Parliament), leaving a balance of £1019. The Directors feel that they cannot, in view of the liability remaining against the Company for the balance of the costs of promoting the Bill in Parliament, recommend any dividend. These costs have not yet been ascertained. His Grace the Duke of Northumberland's one-seventh share of the clear annual profits for the year ending April 30 last, amounts to £347; and after paying this, there will remain, including the balance of profit from the previous year, a sum of £1188 to the credit of the profit and loss account. The Directors formally report that, on July 7 last, the action brought by Mr. J. P. Spencer against the Company (as a test case) with reference to the basis of charge, was tried at Newcastle Assizes before Mr. Justice Grantham, who ruled that the net rental was the basis upon which to levy the water-rates. The Directors therefore, with the support of a Special Committee of shareholders who were appointed at the general meeting, deemed it expedient to reduce the water-rents as from May 1, 1891, by charging upon the rateable value as assessed for the poor-rate, as the most ready method of arriving at a sum to represent net rental. This was done; and the loss of revenue, as shown by the balance-sheet, is due to this action. With reference to the Bill promoted this session in Parliament, and which was sanctioned by the shareholders, the Directors report that it came before a Select Committee of the House of Lords in May, and was thrown out; the preamble not being held to be proved. The Directors recommend that a bonus of £25 be given to the Secretary as an acknowledgment of his extra services during the past seven years in connection with the legal and parliamentary proceedings. The Directors are endeavouring to make arrangements with the Newcastle and Gateshead Water Company for obtaining a further supply of water, which they trust to be able to bring to a successful issue.

CORRESPONDENCE.

[We are not responsible for opinions expressed by correspondents.]

The Presence of Free Ammonia in Gas after Passing through Lime.

SIR,—It was not my intention to criticize Mr. Valon's very able address, and I would not now have written except for Mr. E. L. Pryce's letter which appeared in your last issue (p. 1186).

The point raised by Mr. Pryce occurred to my mind when I heard theaddress read. The idea of gas containing free ammonia at the outlet of lime purifiers, in consequence of the decomposition of fixed ammonium compounds by calcic hydrate, is certainly novel and very questionable. Mr. Pryce asks the question if Mr. Valon ever found any trace of fixed ammonium compounds at the inlet of the purifiers; and he suggests that the trace of free ammonia at the outlet is not due to the decomposition of fixed ammonium compounds, but to the decomposition of calcium cyanate, as set forth by Professor Foster in 1882. This, too, as a thorough solution to the problem, is very doubtful.

I am aware that the cyanides of the alkali metals, when fused in contact with air, absorb oxygen and produce cyanates. Such circumstance does not obtain in a lime purifier.

In my opinion, the presence of free ammonia at the outlet of a lime purifier is not due to the decomposition of fixed ammonium compounds, but to the decomposition of cyanogen by calcic hydrate—calcic oxalate being formed with evolution of ammonia. This was pointed out by me in a pamphlet on tower scrubbers issued by Messrs. Dempster and Sons in 1881, in which I gave the following equation:—

$$2CN + CaHo_2 + 2OH_2 = CaC_2O_4 + 2NH_3$$

Traces of ammonia can always be found at the outlet of a lime purifier, if the gas has been previously entirely freed from free and fixed ammonium compounds.

If the gas be first sent through hydrated oxide of iron, no ammonia will be found when it is afterwards passed through calcic hydrate; clearly showing that the cyanogen is absorbed by the oxide of iron.

Lancaster, June 24, 1892. CHAS. ARMITAGE.

Herring's "Gas-Works Construction."

SIR,—My attention has been called to the fact that, in my remarks upon "Gasholder Construction" in the above-named book, I have made use of the writings of Mr. F. S. Cripps on the subject, without in any way acknowledging the source whence my information was obtained; and I hasten to correct such a serious omission, and tender my sincere apologies to Mr. Cripps for inadvertently using his labours without asking his sanction so to do. The omission, however, I may be permitted to explain, arose through my taking extracts from Mr. Cripps's articles as they were published in the JOURNAL OF GAS LIGHTING, &c., during the years 1887 and 1888; and when preparing my articles on "Gasholder Construction," which appeared in the columns of the *Gas and Water Review* in the spring of 1890, I made use of extracts which had been taken by me from time to time, and was not then aware who was the author of the articles in the JOURNAL.

When revising my articles for publication in book form, I had very little time at my disposal, and, amongst others, the chapters on gasholders went forward to the printer practically as they appeared in the columns of the *Gas and Water Review;* and through this, no doubt, I omitted to correct the former omission. I am nevertheless deeply grieved at this oversight; and will take the earliest opportunity of rectifying the same.

Huddersfield, June 25, 1892. W. R. HERRING.

Electric Lighting at Burnley.—Last Tuesday, Mr. Arnold conducted a Local Government Board inquiry at Burnley relative to an application by the Council to borrow £29,000 for a scheme of electric lighting, which has been provisionally adopted. The inquiry also embraced borrowing powers for £11,000 for gas-works extensions.

Completion of the New Water Scheme for Pontefract.—The Roall water scheme to supply Pontefract and the district with an improved supply of water was completed yesterday week. The first sod of this undertaking was turned on July 25, 1889, by the then Mayor (Mr. W. Mathers); and the work has been satisfactorily carried out under the supervision of Mr. G. Hodson, the Engineer, by Messrs. Vickers and Son, of Nottingham. The mains from the pumping-station at Roall are laid for a distance of nine miles to the storeage reservoir on the Park Hill at Pontefract. The cost of the works will amount to close upon £28,000. Since the completion of the work, the contractors have been encountering serious difficulties. Last Thursday morning, when pumping operations commenced, owing to an accumulation of air in the mains, the pipes burst in Teront Street, Tanshelf, and a large volume of water poured forth, and caused a suspension of traffic. The power required to force the water into the reservoir on the Park Hill is immense, and it is feared other difficulties may arise before the works are a thorough success.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.

The following further progress has been made with Bills:—

Bill read the first time: Ilkley Local Board Bill.

Bills read a second time and committed: Bexhill Water and Gas Bill; Newcastle-upon-Tyne Improvement Bill.

Bills reported: Bexhill Water and Gas Bill; Birmingham Corporation Water Bill; Exmouth and District Water Bill; Newcastle-upon-Tyne Improvement Bill.

Bills read the third time and passed: Bexhill Water and Gas Bill; Birmingham Corporation Water Bill; Bournemouth Improvement Bill; Exmouth and District Water Bill; Lancashire (Middle Ward District) Water Bill; London Water Bill; Newcastle-upon-Tyne Improvement Bill.

Bills Royal assented: Ashton-under-Lyne, Stalybridge, and Dukinfield District Water Bill; Airdrie and Coatbridge Water Bill; Blackburn Corporation Bill; Cleator Moor Local Board (Gas) Bill; East Grinstead Gas and Water Bill; Electric Lighting Provisional Orders Bills (Nos. 1, 2, and 3); Gas Provisional Orders Bill; Glasgow Corporation Water Bill; Ipswich Corporation Bill; Kilmarnock Corporation Water Bill; Mold Water Bill; Newport Corporation Bill; Ormskirk Gas Bill; Pontypridd Water Bill; Rhyl District Water Bill; Southend Gas Bill; Tredegar Local Board Water Bill.

HOUSE OF COMMONS.

The following further progress has been made with Bills:—

Bills read a second time and committed; Electric Lighting Orders Confirmation Bills (Nos. 4, 5, and 6); Water Orders Confirmation Bill.

Bills reported: Electric Lighting Orders Confirmation Bills (Nos. 4 and 6); Uttoxeter Water Bill.

Bills read the third time and passed: Electric Lighting Orders Confirmation Bills (Nos. 4 and 6); Gas Orders Confirmation Bill; Uttoxeter Water Bill.

HOUSE OF COMMONS COMMITTEE ON POLICE AND SANITARY REGULATIONS BILLS (SECTION A).

Monday, May 30.

(*Before Sir* F. SHARPE POWELL, *Bart., Chairman; Mr.* HOBHOUSE, *Mr.* WILSON, *and Mr.* PHILLIPS.)

ILKLEY LOCAL BOARD BILL.

This Bill—which, among other objects, is to empower the Ilkley Local Board to construct additional water-works and improve their existing supply, and also to purchase the undertaking of the Ilkley Gas Company—came to-day before the above-named Committee.

Mr. BALFOUR BROWNE, Q.C., Mr. FREEMAN, and Mr. WAUGH appeared for the promoters; the only opponents of the Bill—the Ilkley Gas Company—being represented by Mr. PEMBROKE STEPHENS, Q.C., and Mr. FORBES LANKESTER.

Mr. BALFOUR BROWNE, in opening the case, said the main object of the Bill was to provide for the compulsory purchase of the works of the Ilkley Gas Company. The Committee were no doubt aware that the Ilkley district was an exceedingly beautiful one, attracting a large number of people. The resident population was about 6000; but when the season was on, the number went up to something like 10,000. It was a most notable health-resort, as was obvious from the fact that the death-rate was only 11·4 per 1000; but leaving out the visitors who were in ill-health when they went there, and who died there, the actual rate fell as low as 9 per 1000. In 1851 the population was 811; in 1861, 1043; in 1871, 2511; in 1881, 4733; and in 1891, 5781. In 1851 there were 155 houses; now there were 1000. The rateable value in 1870 was £11,092; in 1891, it was £33,228. The water and the drainage were excellent; but one of the objects of the Bill was to increase the water supply, and this was unopposed. The Local Board was established in 1869. They were the owners of the water-works, and had also a cottage hospital and a cemetery. They had borrowed £40,663, of which £13,769 had been repaid; so that the balance owing was £26,894. Since his brief had been prepared, about £1000 more had been paid off. Altogether, therefore, the town was in a good financial position. The borrowing powers of the Board amounted to £64,000. Their proposal, shortly put, was to purchase the gas-works by compulsion. The Gas Company said that they did not want to sell; and, of course, under these circumstances, the onus was upon the Local Board to show that the Company should be compelled to part with their business. A gas company's property was no more sacred than any other. A landowner was often forced to relinquish his land at the demand of public bodies; and if he (the learned Counsel) could convince the Committee that it was in the interest of the public that the Company should be compelled to give up their undertaking, he should have substantiated the statement in the preamble of the Bill. The Company was formed in 1856 as a limited liability undertaking. They obtained statutory powers in 1869; and from that time until now they had various Acts of Parliament. Although they were under statutory restrictions devised for the benefit and protection of the consumers, the very last thing the Company had thought of was the interest of their customers. The proposal now was to take the works out of the hands of the people who were not managing them well in the public interest, and to place them in those of the Local Board, who unquestionably would carry them on for the public good, and give full compensation to the Company for their undertaking. Having adduced precedents in support of this proposal, the learned Counsel proceeded to deal with some of the complaints made against the Company. First of all, he said, they refused to light certain public roads—notably the one from Ben Rhydding, one of the largest hydropathic establishments in the district; the reason assigned being that they did not see that there would be adequate remuneration for their outlay. Then the Company insisted upon keeping in their own hands the control of the lamplighters, who were paid by the Local Board, and who, it was reported, did not light the lamps early enough, or put them out too soon. At any rate, the Local Board thought that, as they paid these men, they ought to have some authority over them. Next there was the question of the quality of the gas. Its illuminating power was fixed at 14 candles, which was very low, seeing that throughout England it was 16 candles, while in some places it was 18. The fluctuations, both in pressure and lighting power, had been very great. Another cause of complaint was the inconvenient times chosen by the Company for breaking up the roads to do repairs; and therefore it was thought it would be better for the road authorities to have this matter in their hands. But the principal ground of complaint was that the Company had made very large profits, and that the price charged for gas was kept high. This was one of the strongest reasons adduced for the Company being made to hand over their undertaking to the Local Board. Their finances had been dealt with most unsatisfactorily; and the result had been that the consumers had suffered. For example, the amount raised on shares was only £16,466, while £21,638 had been expended. Where had the difference—the £5172—come from? Out of the profits, which really had been taken from the consumers. It had been obtained from what he did not hesitate to characterize as an illegal source. This amount should have been raised as capital; and then the shares would have been sold at a premium, which would have gone into the undertaking without bearing interest. But by taking the money from the profits, the Company had been able to declare very much larger dividends upon the £16,466 than they would otherwise have been able to pay. The learned Counsel next dealt with the figures in the Company's accounts for the year 1881, and said that in that year the net revenue was only £1819, though they managed to pay dividends to the shareholders amounting to £1271, and transfer £542 to the reserve and £151 to the insurance fund; making altogether £1964. How this was done he did not know. It was quite obvious that it did not come out of the "clear profits of the undertaking" in that one year, which it ought to have done by the Company's own Act. Then in 1884 the same thing took place again. They did not earn £636; but this sum was put away. In 1886, £151 was added to the insurance fund, though it was not earned in that year. This money came from the floating balances, which the Company had no right to have. These balances ought to have been divided between the consumers of gas and the shareholders. In 1879, at the passing of their Act, the Company had, in what they called the reserve fund £3239; but most of this money was, he contended, illegally theirs. It should have been given to the gas consumers. The total capital was £12,100, and according to the Gas-Works Clauses Act, under which they then were, their total reserve fund should have been 10 per cent. on that, and everything beyond had to go in reduction of the price of gas. Now, 10 per cent. upon £12,100 was £1210; and this was all they could legally put to the reserve fund; and yet they had then £3239. Therefore they had £2029 which, if properly employed, would have reduced the price of gas very largely indeed. This he called juggling with the finances in a way which was most inimical to the interests of the consumers in the district. At the present time, out of a reserve fund of upwards of £4000, they had £2873, or 61 per cent. to which they had no right at all. In 1890 the net balance on the year's working, after paying expenses, was £2406. With this they could have paid 14 per cent. upon their old, and 11 per cent. upon their new capital, and at the same time have reduced the price of gas by 4d. per 1000 cubic feet. In all the cases he had mentioned, he asserted that the Company had lamentably failed to carry out the duties entrusted to them by Parliament. Why, then, should they not sell? The Local Board were willing to let the whole matter go to arbitration; and as the price to be paid would be left to arbitrators, he thought probably the Committee would come to the conclusion that these gentlemen would do justice between the parties. The petition of the Company against the Bill was very short. They said that no complaints had been made to them in the matter of the gas; but he (the learned Counsel) would be able to show that this was not the case. All they said was that they should not be compelled to part with their undertaking; but he maintained that the time had come for them to part with it. He therefore asked the Committee to say they would pass it over to the Local Authority, with the hope and confidence that the consumers, managing the concern in their own way and for their own benefit, would in the future get as good gas as now at a much cheaper rate than that at which the Company seemed willing to supply it.

The following witnesses were then called in support of the Bill:—

Mr. *M. Hainsworth*, Clerk and Surveyor to the Local Board, examined by Mr. FREEMAN, gave particulars as to the increase in the population of Ilkley, and the generally improved condition of the town, during the past 30 years. He also explained the causes which led to the promotion of the Bill, which, he said, had the sanction of the ratepayers at a public meeting. The Gas Company having refused to sell their undertaking, the Board had to apply for compulsory powers of purchase. The Company worked chiefly under their Act of 1879, by section 52 of which they could contract with the Local Board for the public lighting. In the opinion of the Board, the Company had not properly carried out the powers entrusted to them; and there had been numerous deputations to the Directors on the matter. Witness gave details as to the movement set on foot for having the Ben Rhydding Road lighted. This road had, he said, been dedicated to the public; but it was not a Local Board road. The distance the mains would have had to be laid was something like 700 yards; and the cost would have been about £90. The Board were willing to erect seven lamps; and this would have given the Company a fair return on their outlay. All the land on one side of the road had been sold for building purposes; and the want of light there had, no doubt, interfered with the development of building along it. On some occasions the Board had had to refund to the Company the cost of laying the mains, in order to get them to supply the gas. The public lamps were not lit from the

middle of May to August. The Board desired to have the lamplighters under their own control. The lamps had been sometimes turned out before the prescribed period; and he had heard complaints of this in different parts of the town, and also as to the quality and pressure of the gas. At the public meeting there was a strong feeling in favour of the purchase of the gas-works.

Tuesday, May 31.

On the resumption of the proceedings to-day,

Mr. *Hainsworth* was cross-examined by Mr. PEMBROKE STEPHENS on the subject of the complaints made against the Company—the subject of the lighting of the public roads being taken first. Asked if there was any road he could mention where the Company had been requested to put down mains and had not done so, witness said there was only one case—that of Bridge Lane, for the mains in which the Local Board had paid £8, and then they had the gas. As to the private roads, the Board made a point of the Ben Rhydding Road, because it was really a public road, and Ben Rhydding itself was lighted by the Company. The length of this road and the Keighley road was 1200 yards together, and there were 500 yards of mains laid in the Keighley road portion. As a matter of fact, the Ben Rhydding Road was not vested in the Local Board, and they would not repair it.

Mr. PEMBROKE STEPHENS: If it is not a public, but a private road do you not know that the owners of a private road have perfect power, if they choose, to call upon the Gas Company to lay down a main?

Witness: No; I did not, at the time.

Your complaint is that the Board, who were not owners of the land, were calling upon the Company, who would have nothing to do with the road; and you did not know that the owners of the road had a statutory power, if they thought proper, of requiring the Company to light that road. What has been the complaint between you and the Company?—It was not so much between us and the Company; but the public complained as to the lateness of the hour at which the lamps were lit, and the early hour at which they were turned out.

Are the lamps lighted all the year round?—No; only during the winter months. They are not lit from the middle of May to the middle of August. The Board decide when the lamps are to be lighted.

Therefore, if there is any part of the year when there is no lighting at all, that is the act of the Local Board?—It is. I might say that that is not the complaint at all. The complaint was in connection with the turning out of the lights earlier than they were ordered to be extinguished. We said twelve o'clock; and on one occasion they were put out at half-past eleven. I never complained, in writing, to the Secretary of the Company; but on one occasion I did so to the Manager. It was just before last Christmas—a few weeks after the Bill had been deposited.

In further cross-examination, witness said that under the Act of 1869 the price of gas was 6s. per 1000 cubic feet, and that it was reduced to 5s. 6d. under the Act of 1871, and to 4s. under that of 1879. Since then the price had been successively lowered to 3s. 8d., 3s. 4d., and 3s. He acknowledged that any reduction in price must be a voluntary act on the part of the Company. He was not aware that the 4s. limit was fixed at the instance of the Local Board themselves.

Mr. PEMBROKE STEPHENS: You have made complaints that there have been all sorts of irregularities—"juggling" was the word used—with regard to our accounts. Now, having them before you year by year, and having gone back, I think, in one case to the year 1881, to try and pick holes in them, when did the Local Board first communicate to the Company, officially and in writing, that their view was that there was nothing wrong in those accounts?

Witness: I do not know that we made such a communication. I have never heard of it.

When did the idea first occur to you?—When the accountant went through the books on the 17th of August last year.

How did that gentleman come to get into relation with the books of the Company, and to overhaul them in August, 1891?—Through the permission of the Directors of the Company—as a matter of courtesy to the Local Board.

It is not the usual thing, is it, for the solicitors of a Bill for compulsory purchase to overhaul the books of a gas company whose works it was desired to acquire?—In the first place, the Local Board decided to send a deputation to the Company to consider the purchase of the gas undertaking.

The CHAIRMAN: We do not want to get involved in an investigation into these negotiations.

Mr. PEMBROKE STEPHENS: You may take this fact from me, sir, that, there being a power under the Public Health Act, as you know, for people to agree together, the Local Board, purely of their own motion, sent a deputation to the Company, and asked them to name a price for their undertaking. The Company told them they did not wish to sell, as they were perfectly satisfied with their business; but that, if the Board wanted to purchase, they might make an offer, which would be considered. The Local Board thereupon wrote: "Before we make an offer, we should like to have an opportunity of looking at your books." The whole thing was done in a friendly way; and the Company met the Board in an equally friendly manner, and said: "It is not a usual thing, but you shall have the opportunity of seeing our books." The Board were not satisfied with that, but said there were some books in a different place which they wanted to inspect; and they wrote for leave to go into these also. This led up to the discussions as to price, and so on.

The CHAIRMAN: It led to negotiations which proved abortive.

Mr. PEMBROKE STEPHENS: We never went into a negotiation at all, but, for their own satisfaction and guidance, the Board asked for this information; and what we feel to be the peculiar sting of this matter now is that the very opportunities we gave, as one body dealing honourably, and even extra-honourably, with another, are absolutely tortured into an attack upon the Company for having "juggled" with their accounts.

Further cross-examined, witness said the question of the cost to the town of the proposed purchase was discussed at the ratepayers' meeting; and he thought it was stated that it would add 1s. or 1s. 6d. in the pound to the rates. The Bill before the Committee was practically the one submitted to the meeting, and assented to.

Re-examined by Mr. WAUGH: The meeting was the largest I have ever known during the time I have been connected with Ilkley. The price of gas has upon three occasions been reduced since the 1879 Act was passed. In consequence of the reduction, there was an increase in the dividend to 13 per cent. upon the original shares, and 10 per cent. on the second issues. At the present time on the Ben Rhydding Road, they are in pitch darkness during the night. The fact that that road is unlighted has a detrimental effect upon the development of that part of the town. The Board would have ordered the lamps to have been lit for extra time had the gas been cheaper. The Company have persistently refused the applications of the Local Board as regards lighting generally.

By Mr. WILSON: There are about 982 houses in Ilkley, and there are about 1100 or 1200 ratepayers; so that the number of persons present—200—at the meeting on Oct. 21 was one-sixth of the whole of the ratepayers.

Mr. BALFOUR BROWNE said as the Ben Rhydding Road was a highway for all practical purposes, he submitted that it was a highway for the purpose of having gas-pipes laid down.

Mr. PEMBROKE STEPHENS said that if his friend relied on that case, he should want to have it proved in evidence.

Mr. *Jabez Dobson*, Chairman of the Ilkley Local Board, examined by Mr. WAUGH, said he was a large consumer of gas; his gas bill amounting to about £230 per annum. He had on several occasions complained to the Manager of the Company with regard to both the pressure and the quality of the gas supplied; and no attention had been paid thereto. As Chairman of the Local Board, he had had complaints made to him from other consumers of gas. He had applied to the Company, as being one of the largest customers, to be allowed a discount, in order to use gas for cooking purposes; and they had refused.

In cross-examination by Mr. PEMBROKE STEPHENS, witness said he could not give the dates of his verbal complaints; but it would be two to three years ago. He was told that his service-pipe was old, and required repairing. He attached great importance to the matter of the cooking-stove. In the Bill, reference was made to the supply of gas for cooking purposes, and as to the Local Board purchasing and letting on hire gas stoves and other appliances. This was not his suggestion.

Mr. *Garside*, a plumber carrying on business at Ilkley, spoke to complaints having been made as to the quality and the pressure of the gas; and he said he had heard of cases where it had been given up altogether. There was not a sufficient supply for culinary purposes.

Mr. *J. Wilde*, a stationer and picture dealer, said he had 12 burners in his shop and about the same number in his house. In consequence of the unsatisfactory state of the gas, he tried to improve his light by adopting larger burners; but this did no good, and only damaged his goods. He had two gas-stoves for heating purposes. As soon as the lamps were lit in the streets, the pressure of gas in the stoves was very much reduced; and when, in addition, the churches and chapels were lighted up, it was worse. He had complained of the sulphurous smell of the gas. He considered that the inhabitants were inconvenienced by the Company breaking up the roads at unsuitable times.

Mr. *J. T. Richmond*, Mr. *E. Ibberson*, and Mr. *H. Ellis* gave similar evidence.

Mr. *E. Walmsley*, accountancy clerk to Messrs. Berry, Robinson, and Scott, Solicitors for the Bill, examined by Mr. BALFOUR BROWNE, said he received instructions to get a general knowledge of the accounts of the Gas Company, with the view of the Local Board acquiring their undertaking. With respect to the dividends paid by the Company, they were shown in his summary, and were as follows: In 1856, no dividend; in 1857, 4 per cent.; in 1858 and 1859, no dividend; in 1860, 3 per cent.; in 1861, 3½ per cent.; in 1862, 4½ per cent.; in 1863, 5 per cent.; in 1864, 5½ per cent.; in 1865, 7 per cent.; in 1866, 8 per cent.; in 1867, 8 per cent.; in 1868, 8 per cent. In 1869 there was a division of £2 per share, amounting to £420, besides which the shareholders received 10 per cent. dividend; making 30 per cent. for the year. With regard to the reserve fund, at the time the 1879 Act was passed, the surplus profits shown in the accounts amounted to £3239. This should have been, if the Company were right, only one-tenth on their paid-up capital of £12,100—viz., £1210. They had, therefore, in excess of this, a sum of £2029. In 1881 they added surplus profits of £542; and in 1882, £301. Therefore, the amount in excess of section 16 of the Act of 1879 was, according to his figures, £2873. The old Acts of 1869 and 1871 did not mention a reserve fund at all. The £2029 was brought forward with the reserve fund under the Act of 1879; and the whole of it was treated really as a reserve fund. In the years 1881 and 1882, when the sums of £542 and £301 were added to the reserve fund, the Company had no right to add anything. So that there were illegal additions to the reserve fund of £843. As to the insurance fund, by section 14 of the Act of 1879, out of the excess of profit on any one year the Company could set aside 1 per cent. on the paid-up capital. This meant £151; and they could accumulate it until the reserve fund equalled 1-20th of the paid-up capital. The first £151 was placed to the insurance fund in the year 1880. They had put money into this fund when there was no excess of profits properly to go into it. In 1881 they placed £151 there; and the same amount in 1882. In 1884 a sum of £151 was placed to the fund. In that year they had to take £636 out of their surplus to pay dividends; and yet the Company put £151 to the reserve fund when Parliament said they should not do so.

The Committee then adjourned till Thursday.

Thursday, June 2.

On the proceedings being resumed to-day,

Mr. *Walmsley*, further examined, said he had found that the undivided profits of the Company up to the passing of the Act of 1879 now formed part of the reserve. In 1879 the revenue balances commenced with £606; and at the end of 1890 they had accumulated to £3163. The undivided profits consisted of three items, making a total up to the end of 1891 of £9509; and then there was the interest of £61 on the investments of 1891. The ultimate total was therefore £9570. In 1884 there was a sum of £2000 charged to revenue which should have been charged to capital. In 1888 nothing was put down to capital; and there were doubtful items of about £400 which admittedly should have been charged to this account.

In cross-examination by Mr. PEMBROKE STEPHENS, witness said he

considered he had a roving commission to go back to the starting of the Company. He wanted to get at the formation of the capital account. In all cases the yearly accounts had been made out in the form required by the Act of Parliament. One of his employers, who were getting up the Bill, suggested he should go more deeply into section 16 of the Act of 1879.

Witness's report having been put in.

Mr. PEMBROKE STEPHENS remarked that the figures were widely different from those in the summary. The report was made in September, and it appeared that Mr. Walmsley was quite satisfied until somebody suggested he had not properly read one section in the Act of Parliament; and since then he (Counsel) supposed another set of figures had been made out.

Witness: Indeed they have not—not a single figure.

Re-examined by Mr. FREEMAN, witness said that, in order to verify his six years' account, he went back as far as was necessary to get the actual facts from the Company's accounts, and nothing more.

Mr. *W. Woodhead*, examined by Mr. WAUGH, gave particulars of the gas supply of several places adjacent to Ilkley; and said the charge in this town—3s. 4d. per 1000 cubic feet, with no discount—was 20 per cent. above the averages of its three nearest neighbours.

Mr. *T. Newbigging*, M.Inst.C.E., examined by Mr. FREEMAN, said that, in his opinion, the purchase of the gas undertaking by the Local Board would be for the general advantage of Ilkley. Of course, its full value should be paid to the Company. He had known hundreds of cases where the private roads had been lighted by the company; but in this instance they had not. He did not think they had shown a liberal spirit with regard to public lighting; and he considered the control of the lamplighters should be in the hands of the Local Board, as it would be for the public benefit. What was wanted was gas of good steady illuminating power, not too high—say, 17½ candles. A good many things in the accounts were reprehensible, and showed that an extreme profit had been made out of the consumers. For 1890 the expenditure on capital account was exceeded by no less than £5171, representing 25 per cent. of the total capital. The balance of the reserve fund and the insurance fund was £8637. There was a half-year's dividend due on the balance of revenue; and if this was deducted, it would come to £3163. He believed that a considerable amount had been taken out of the pockets of the consumers for the purpose of enlarging and extending the works. The Company had sold 410 shares by auction; and it happened to be suspiciously near the time of giving the notice for the Bill. These shares represented a sum realized in the open market of £6726; and this appeared in the Company's accounts for 1891 as if it were expended for recent works. The reserve fund—£4689—which appeared in the accounts of 1890, was an entirely distinct fund from the floating revenue. In the year 1879 this fund stood in the books at £3239; and it was clearly in excess of the sum which the Company were entitled by law to have put away as a reserve. In 1881 they illegally carried no less than £542 to the reserve fund out of the excess profits of the year; and in 1882 they pursued the same policy. In 1879 the Company illegally carried to the reserve fund £2029; in 1881, £542; and in 1882, £302—in all, £2873, or 61 per cent. of the total amount of the fund. The sum required to pay an increased dividend of 1 per cent. on the capital was £151; and to allow the Company to pay this, the price of gas would have to be reduced 4d. per 1000 cubic feet, which, on a consumption of 35 millions, came to £587—making together, £738. That was to say, the Company had to spend £738 by increasing the dividend 1 per cent. They would appropriate £151 themselves, and would give the consumers £587. The Board were anxious to give the full value for the property; and if the Company were paid a fair price, there would be no hardship whatever.

In cross-examination, witness cited the case of Stafford, in 1878, where the compulsory purchase of the gas-works was sanctioned by Parliament, as an instance of a proposal such as that of the promoters. He admitted that there the Company did not oppose.

Mr. *C. Gott*, M.Inst.C.E., of Bradford, gave corroborative evidence.

This closed the promoters' case; and witnesses were then called for the opponents.

Mr. *W. F. Potter*, M.Inst.C.E., in examination by Mr. FORBES LANKESTER, said he had lived at Ilkley for ten years, and had paid a considerable sum annually for gas. He had never had occasion to make any complaint as to its quality; and, personally, he was quite satisfied with it. He had had some experience of the gas supplied at Leeds by the Corporation; and he thought the Ilkley gas compared very favourably with it. He had no knowledge of any feeling in favour of the compulsory purchase of the gas-works at Ilkley; and had not heard any strong expressions of anxiety that they should be bought—indeed, he did not remember having heard the question discussed at all. He should say that the public interest in the thing was very slight; and he thought it was undesirable that the Board should acquire such an undertaking. He knew Mr. Wedgwood, the Company's Manager, and had never had reason to complain of want of courtesy on his part; but quite the contrary. On many occasions when he had seen him in connection with the gas supply of his house, he had always been treated with the greatest consideration.

Cross-examined by Mr. WAUGH, witness said his opinion was that the proposed purchase would be a mistake. The Local Board had too much in hand already. Probably the electric light would come into use at Ilkley; and therefore it would be financially detrimental to the ratepayers if the Board acquired the works. On account of its water supply, the town was peculiarly suited for having the electric light.

Mr. *W. Crowe* confirmed the statement of the preceding witness as to there being no strong feeling at Ilkley in favour of the purchase of the gas-works by the Local Board. He believed the real desire of the inhabitants was that they should be left in the Company's hands, as the Board had sufficient to do at the present time. As to the quality of the gas, witness said he had never had any cause of complaint.

Mr. *W. Johnson*, a restaurant keeper and confectioner in the main street of Ilkley, said he had lived in the town for 28 years. He had gas-ovens, gas-stoves, and fires in constant use, and paid a considerable sum annually to the Company—from £19 to £22. He had never had any cause to complain of the pressure or the quality of the gas. He had known Mr. Wedgwood for a long time, and had always found him courteous and pleasant. His opinion was that the people of Ilkley were rather in favour of the Company carrying on the gas-works; there being a feeling that the Local Board had quite enough to attend to.

Friday, June 3.

Mr. *W. Wedgwood* was called to-day, and stated that he had been Manager of the Ilkley Gas Company for many years. As far as he knew, the Company had always endeavoured to fulfil their duty to the public. No written complaints from the Local Board as to the quality of the gas had ever been received; nor had they had any substantial verbal complaint. There was a difficulty in furnishing a uniform supply of gas in Ilkley, owing to its hilly nature; but this could be remedied by the consumers putting in governors. The witness dealt in detail with the evidence given by the promoters' witnesses as to the complaints made against the Company; saying that as to some of them he had only heard them in the Committee-room, and that generally the defective supply was owing to the size of the service-pipes. Although the illuminating power of the gas was fixed at only 14 candles, the Company actually supplied it of 17·43-candle power.

Mr. *C. Beevers*, Secretary and Accountant to the Company, said that there had never been a whisper on the part of the Local Board of objection to the manner in which the accounts were kept until the Bill was brought forward. He denied generally that there was anything wrong in the way in which the reserve and insurance funds had been accumulated. As to the floating balances, he could not see, under the Act, how they could have dealt with them in any other way than they did. He believed, too, their way of dealing with them was the most economical for the consumers.

In cross-examination, witness admitted that at the time of the passing of the Act of 1879 the reserve fund was £2029 more than the Company were entitled to under the Gas-Works Clauses Act; but Parliament, in the Ilkley Gas Act of 1879, authorized them to carry forward any reserve they might have.

The CHAIRMAN asked whether there was any doubt that, to a certain extent, large or small, there had been some departure from the statutory requirements.

Mr. PEMBROKE STEPHENS said that before 1879 there was a sum of £2000 more in the reserve fund than the General Act authorized; but he did not go any further than that.

The further consideration of the gas portion of the Bill was then postponed.

Tuesday, June 14.

To-day further evidence was given on behalf of the opponents.

Mr. *J. E. Kirby*, examined by Mr. PEMBROKE STEPHENS, said he was Manager of the Ben Rhydding Hydropathic Establishment. They were amongst the largest consumers of gas in the district, and paid about £120 a year for their supply. They certainly had no reason to complain either as to quantity or quality. The Manager of the Gas Company had always, in his opinion, been anxious to oblige consumers. The proposal of the Local Board to take over the gas-works against the wishes of the Company, was one to which he (witness) was strongly opposed.

Mr. BALFOUR BROWNE: Why are you strongly opposed to the proposition?

Witness: Because I think it would be wrong for the Board to acquire the gas undertaking when we have a prospect of electric lighting.

Witness was cross-examined in great detail as to local complaints of defective supply which had been brought forward in evidence; but he maintained that, so far as his experience went, the quantity of gas was adequate.

Mr. *Greaves*, a plumber and gas-fitter, and Mr. *Parkinson*, a consumer, supported the statements as to the sufficiency of the supply, and expressed their disapproval of the Local Board's project to acquire the gas-works.

Mr. *Charles Hawksley* was called, and examined by Mr. PEMBROKE STEPHENS. He said he had made himself acquainted with the proposal in the Bill to enable the Local Board to acquire, by compulsory purchase, the undertaking of the Gas Company. He believed there was no precedent whatever for such a transfer being sanctioned by Parliament—that was to say, no precedent for the acquisition of a company's works against the wishes of that company, where there had been no special circumstances to justify its interference.

Mr. PEMBROKE STEPHENS: In your opinion, are there any special circumstances to justify the compulsory transfer of this undertaking?

Witness: None whatever. The works are unusually good for such a place; and the concern has been regulated and controlled in such a manner as to reflect the utmost credit upon the management. I see no possible improvement that can follow from the transfer of the works from the Company to the Local Board. In fact, I do not think the Local Board could manage them better, or even so well, as they are being conducted at present. I think also that the Local Board might be much better employed in seeing that the Company do their duty, rather than in trying to do the work themselves.

In further examination, witness said he attached no importance to the argument advanced in justification of the Bill, that it would prevent the breaking up of the streets. That would continue as heretofore. He had examined the affairs of the Company; and, comparing them with those of similar undertakings, he thought they had been economically managed, and that the works had been properly maintained.

Mr. BALFOUR BROWNE said the witness had no knowledge of a case in which the compulsory acquisition of such an undertaking as that of the opponents had been sanctioned by Parliament. They had such knowledge, and therefore he did not propose to pursue the question.

Witness: I have no knowledge of a case where it has been sanctioned without the consent of the company.

Mr. BALFOUR BROWNE: Your opinion is that, if the works pass from the hands of the Company into those of the Local Board, they will not be so well managed?

Witness: Yes, that is my opinion.

The CHAIRMAN: Are you about to contend, Mr. Browne, on the part of the Local Board, that Parliament has been in the habit of giving such compulsory powers as those sought for here?

Mr. BALFOUR BROWNE: Most certainly, Sir.

Cross-examined as to the adequacy of the supply, witness expressed the opinion that there was no cause for complaint.

Mr. PHILLIPS asked whether the "juggling" with the Company's accounts in the creation of a reserve fund, to which reference had several times been made, would be sufficient justification for Parliament sanctioning the compulsory transfer of the undertaking.

Witness replied that he did not think it would. If there had been a "juggling" with the accounts, there was a remedy in the Courts of Law; and it was unnecessary to introduce a Bill into Parliament to obtain it. He admitted that, if the undertaking were being grossly mismanaged, and it could be shown that the Company were unwilling to improve, there might be some justification for its compulsory acquisition.

Mr. PEMBROKE STEPHENS said this closed the evidence on the part of the opponents.

The room was then cleared. On the public being re-admitted.

The CHAIRMAN said the Committee had been considering the proposals of the Bill with the view of saving time. With regard to the minor points—as to the question of the non-lighting of roads, and the turning out of lights too soon—they did not attach any importance to them; and their decision would not be affected by them. The matter they wished to hear Counsel upon was as to the allegations with reference to the Company's reserve fund and the floating balance.

Mr. PEMBROKE STEPHENS then addressed the Committee on behalf of the opponents. At the outset, he denied that any advantage would accrue to the consumers from the proposed purchase of the gas-works. He contended that there was nothing illegal in the transfer to a reserve fund of the balance existing at the time of the passing of the Act of 1879; indeed, to his mind, there was no other mode of dealing with it. He hoped he had satisfied the Committee that the circumstances of 1879, and those of the passing of the Gas-Works Clauses Act of 1847 were entirely different. He contended that this was, from the beginning to the end, a Local Board Bill, and not a consumers' Bill. Nearly all the witnesses called in support of it, with a few exceptions, were members and servants of the Local Board. Mr. Walmsley's accounts were, he urged, genuine and honest figures from first to last, given with the view of purchase by agreement; and in the report made in September, it never crossed his mind that anything was wrong in them. It was a noticeable fact that it was not proposed in the Bill to pledge the rates of the town at all to raise the money for the purchase of the concern. The Board were to raise it by mortgage of the undertaking. Such a purchase as that was, he asserted, absolutely unheard of. This was a Bill in which, by false pretences, they had got hold of the Company's books; and those books, he submitted, had thoroughly stood the scrutiny to which they had been submitted. The promoters had brought forward a scheme of purchase which, on the face of it, was one that did not cost them a penny. They proposed to make over the gas property to themselves, with the one object of giving themselves the profits; and he said that, looking at the case as a whole, both in law and in fact, and at the way in which the information had been obtained and used, it was an underhand, a mean, and a dishonest Bill, and therefore he hoped the Committee would reject it.

Mr. BALFOUR BROWNE, in summing up the case for the promoters, contended that their case as to complaints of deficient quality and pressure of gas, and "juggling" or manipulation of the accounts, had been fully proved. He submitted that, as to the "juggling," there had been no answer attempted to what he had said in his opening. He said, without hesitation, that there were dozens of cases in which compulsion had been put upon companies in Parliament to sell. The Company had not done their duty to the consumers; and he maintained the time had come when they should part with their property.

The room was then cleared. On the re-admission of the parties,

The CHAIRMAN said: I am desired by the Committee to say that we deem it expedient to empower the Local Board to acquire the undertaking and powers of the Gas Company to supply gas within the present limits of the supply of the Company; but any question as to the extension to Denton must be reserved.

The opposed portion of the Bill having been disposed of, the Committee adjourned till the following day, when the clauses were considered. Those relating to the purchase of the gas-works were passed; the one reserved, sanctioning the extension of the limits of supply to Denton, being agreed to. On the financial portion of the Bill, the Committee gave the necessary power to raise money for the purchase of the works and such further sum for working capital, &c., as the Local Government Board shall approve; the whole amount to be repaid in 30 years.

Water-Works for Standish.—The Local Government Board have approved of the borrowing of £12,000 by the Standish Local Board, for the purpose of constructing water-works for the district.

A Gravitation Water Scheme for Carlisle.—Mr. J. Hepworth, the Engineer of the gas and water works of the Carlisle Corporation, has recently presented to his Committee a report in which he deals with the present system of water supply and with the Cairn, Caldew, and Overwater as sources of supply by gravitation. He states that from 1866 to 1891 the total amount expended on the present water-works was £68,264; and the total amount now owing is £20,120. The revenue from the sale of water has increased from £2808 in 1866, to £7170 in 1891. It is now necessary to provide a new storeage reservoir at Newlands, near Carleton, which will cost, with pumping engine, machinery, and mains, £25,000 to £30,000. Of the three sources for a gravitation supply, there can be no doubt as to the superiority of the Caldew. The quantity of the water is abundant and much in excess of the requirements of the city and immediate neighbourhood. The quality of the water is also excellent, as indicated by analyses made by Mr. W. Foster, M.A. The Gas and Water Committee have reported to the Council that they are of opinion (1) that the time has come when it is necessary to take steps to extend and improve the water supply of the city; (2) that such extensions and improvements would be most satisfactorily met by a gravitation scheme; (3) that the Council should authorize them to call in a consulting engineer to advise and report. The reports will be discussed by the Council at their next meeting.

MISCELLANEOUS NEWS.

THE INSPECTION OF GAS-LIQUOR WORKS UNDER THE ALKALI ACT.

The Sub-Inspectors' Reports.

In a recent number of the JOURNAL (p. 1075), we noticed the report of the Chief Inspector under the Alkali, &c., Works Regulation Act, 1881 (Mr. A. E. Fletcher), for the past year. We now give a few extracts from the reports made to him by the Inspectors of the various districts into which the area under his supervision is divided. These are: (1) Ireland, Mr. W. S. Curphey, F.I.C., F.C.S.; (2) North of England, Mr. B. E. Smith, F.I.C., F.C.S.; (3) Cheshire, North Wales, and part of Lancashire, Mr. E. G. Ballard, with whom is associated Mr. J. Affleck, M.A., D.Sc., as an additional Inspector for the Widnes sub-district, comprising Widnes and Runcorn; (4) East Lancashire and Yorkshire, Mr. R. Forbes Carpenter, F.I.C.; (5) South Midland, Mr. E. Jackson, F.I.C., F.C.S.; (6) South-West of England and South Wales, Mr. A. C. Fryer, Ph.D., M.A.; (7) South of England, Mr. Brereton Todd, assisted by Mr. F. N. Sutton, F.I.C., F.C.S. Scotland—divided between Dr. Blatherwick and Mr. W. S. Curphey—is, as usual, the subject of a separate report.

In Ireland there are 20 sulphate of ammonia works, which last year produced 2645 tons of sulphate. The general conditions under which these works are carried on has not changed since the previous report; the noxious gases given off during manufacture continuing, in some of the smaller works, to be destroyed by fire.

In the North of England, there are 34 works employed in the manufacture of sulphate of ammonia; the quantity produced being 4273 tons. In two cases, the liquor results from the condensation of gases from coke-ovens; 575 tons being derived therefrom. Tar, benzol, and naphthalene are also obtained in considerable quantities from the same source. There is one gas-liquor works in the district; but the only operation carried on is the concentration of the liquor. A small amount of liquid ammonia is also made by distillation from sulphate. The Chance-Claus sulphur-recovery process still gives rise to complaint, although the District Inspector acknowledges with pleasure the measures adopted to remedy the defects causing the nuisance. The sulphuretted hydrogen in the residual gases is now burnt in specially constructed furnaces; the final escape taking place by means of a high chimney. Some idea of the enormous volume of gases to be dealt with may be realized from the fact that, in one of the works in the district, 5,040,000 cubic feet of mixed air and sulphuretted hydrogen are disposed of every 24 hours, and the weekly output amounts to 200 tons of sulphur. There are in the district two Claus sulphur-recovery plants, both attached to plant for the manufacture of sulphate of ammonia. The output of sulphur is small; and the exit gases are successfully treated by a lime tower and an oxide purifier.

In the portion of district No. 3 which is under the supervision of Mr. Ballard, two new works for the manufacture of sulphate of ammonia have been added since the previous report. At one of the older works, the continuous system of distillation has been substituted for the intermittent process. With one exception (and in this case a prosecution was instituted), he always found the works in good order when he visited them. Of the works manufacturing sulphate of ammonia (some of which are registered as manure works) there are 12 working on the continuous, and 14 on the intermittent system of distillation; 17 absorb the sulphuretted hydrogen by an oxide purifier; 8 burn it; and in one case it is converted into sulphur in a Claus kiln. The total quantity of sulphate of ammonia made in the district (excluding the Widnes and Runcorn sub-district) last year was 2878 tons. A large portion of Mr. Affleck's report is devoted to the Chance-Claus process for the recovery of sulphur from alkali waste. By it there were recovered last year 21,041 tons of sulphur, and 10,400 tons of sulphuric acid; but the latter is no longer made—the production of sulphur being found much more profitable. The few works in which salts of ammonia are produced in the district remain as before. No changes were effected in the plant; and there were no complaints of nuisance. The production of sulphate and muriate of ammonia amounted to a quantity equal to 909 tons of sulphate.

The number of gas-liquor works registered in Mr. Forbes Carpenter's district decreased by one last year; and one fresh works was started. The total quantity of ammonia manufactured into sulphate, muriate, and liquor ammonia (crude and refined) was equivalent to 24,700 tons of sulphate of ammonia. Of the methods used for dealing with the waste gases, absorption by oxide of iron in open purifiers is adopted in the large majority of works; but combustion to sulphur dioxide as a source of supply to the vitriol chambers, where these exist, still continues a favourite method, and obtains with 36 per cent. of the sulphate of ammonia made—oxide being used with 46·5 per cent. The Claus process is in use in four works, where it is well liked and successfully worked. It can only be employed to advantage in large works having continuous plant in full operation during the week. Plant of the continuous type is steadily replacing that of the intermittent kind. Only 7 per cent. of the total sulphate made is manufactured by plant of the latter description. In the continuous plants, the evolution of foul gases, being more steady and uniform, enables these to be dealt with more advantageously, especially where they pass to the vitriol chambers, in which process regularity of supply is absolutely essential.

Mr. Jackson reports that, in the South Midland district, the manufacture of either sulphate or muriate of ammonia was carried on last year in 69 works; being a net increase of seven, as compared with 1890. In eight works, the resulting sulphuretted hydrogen is burnt for the production of oil of vitriol—an operation which, he says, is attended with obvious advantages. In four works, the Claus process is used, with a final limestone scrubber and an open oxide purifier. In these works the purifying arrangements have been found ample for effectually preventing the escape of noxious gases, although the proportions of sulphuretted hydrogen and sulphur dioxide leaving the chambers have been found exceedingly variable. Referring to the cost of working the various processes now in use for dealing with the

former gas, Mr. Jackson says it is interesting to know that at least at one sulphate of ammonia works in his district using the Claus apparatus, where the figures have been very carefully gone into, the entire expense of purifying the noxious gases has been covered by the sale of the recovered sulphur—leaving a balance on the right side. This cannot, he fears, be said of oxide purification, as, with a large make of sulphate of ammonia, the cost of labour, &c., in emptying the purifiers, becomes an important factor. In two works the noxious gases are still passed into the hydraulic main; in two others, lime is used in the purifiers; and in the remainder, the usual method adopted is the open oxide purifier. Three works have added coke scrubbers to the condensing plant, for more effectually drying the gases passing to the purifying apparatus. There are 14 works in which this form of condenser is now used. The gradual extension of the continuous method of distilling gas liquor in place of the intermittent plan, has again to be noted. The disposal of the spent liquor and the highly offensive water from the condensers gave much trouble last year in several places. In many works, this water has hitherto been mixed with the limed spent liquor, which, after settling and cooling, has been allowed to pass into the watercourses or sewers. Its elimination must now be looked upon, however, as a very advisable precaution; and after this has been done, in most cases the spent limed liquor settled and cooled is deemed sufficiently purified. At several works, where the soil has been suitable, a large reservoir has been made, into which the liquors are run and allowed to filter away, and are thus supposed to be gradually purified; but, Mr. Jackson says, the special circumstances and surroundings have to be well considered before such a plan can be recommended. In one case, where this method of disposal was adopted, it had to be abandoned. Such are the special difficulties experienced at two works, that all the spent liquors are evaporated. In all cases it is safer and better to treat the water separately. There are two plans frequently used in the district. In many sulphate of ammonia works attached to gas-works, it is conveyed to the ash-pits under the retort-beds, and so evaporated; the offensive steam passing through the heated flues, where the noxious gases are burnt. Another plan employed at several of the large works is to return the water to the still; the sulphuretted hydrogen contained in it thus passing on to the purifying apparatus. This method is a most satisfactory one from the point of view of diminishing nuisance, as it effectually disposes of all the sulphuretted hydrogen generated during the distillation; but the necessary increase in fuel rather makes against its general adoption. The most notable improvement in this class of works during the year was in one where the special difficulties of the case, consequent on the varying composition of the gases with admixture of air, required most careful investigation and consideration. Year by year advance has been made, and many methods have been tried; and now Mr. Jackson is pleased to report that a plan has been devised, and plant erected at considerable cost, whereby the noxious gases are satisfactorily dealt with. Six new sulphate of ammonia works were erected last year, particulars of which are furnished.

Coming to the district embracing the South-West of England and South Wales, we find Dr. Fryer reports that there are 65 registered works where the manufacture of muriate and sulphate of ammonia is carried on, and these produced last year 6900 tons of ammonia salts. A new plant was erected at one works; and the man in charge being not sufficiently acquainted with the details of its working, a serious escape of sulphuretted hydrogen took place. The town authorities, and also the owners of the works, at once communicated with the Inspector, whose suggestions were carefully attended to; and no further nuisance has been complained of. At another works the man employed at the saturator suffered from inflamed eyes, and was unable to attend to his duties for several days. The saturator was in good condition; and Dr. Fryer thinks the illness of the attendant may have been caused by the action of sulphuretted hydrogen and steam upon his eyes. A similar case was noticed in the previous report in the Manchester district; and Mr. Carpenter, after giving some details, added: "It would appear that when the saturator, from the open side of which the salt is fished, is working under much back-pressure (4 to 5 inches of water), and at the same time the acid used is not free from nitrous compounds, the sulphuretted hydrogen will discharge itself, as will also nitrous gases when present in quantity, from the open surface of the liquor. Neither cause seems sufficient in itself, unless aided by the other, to produce this reaction." Various modifications of the simple form of oxide of iron purifier which Mr. J. J. Jervis first made use of at the New Swindon Gas-Works* are now in operation. This simple heap of oxide of iron was found to work effectively at several of the smaller works; and now the Bath Gas Company have given it a trial for twelve months, with the result that the Manager (Mr. C. Stafford Ellery) is so well satisfied that he has removed the ordinary enclosed form of purifier.

In the Southern district, the portion supervised by Mr. Brereton Todd contains 37 works for the manufacture of sulphate of ammonia. In every case the sulphuretted hydrogen evolved in the distillation process is dealt with in an efficient manner. Two of the largest works use the Claus sulphur-recovery process; and the waste gases from the depositing chambers are finally absorbed in limestone towers and oxide purifiers. In one works the sulphuretted hydrogen evolved is burnt, and the resulting sulphurous acid is passed into the vitriol chambers, where it is utilized for making acid. Only one other works burns the foul gases; and this is done efficiently in a special furnace —the sulphurous acid being allowed to pass up the chimney. All the remaining works, after thoroughly cooling and condensing the watery vapour in the foul saturator gases, absorb the sulphuretted hydrogen in oxide of iron purifiers. Many of the close saturators are being replaced by open curtained saturators, from which the salt is fished direct. This does away with the unpleasant smell of the steam produced during evaporation, and is at the same time a more economical method. The total quantity of sulphate of ammonia turned out during the year was just over 5000 tons. In Mr. Sutton's portion of the district, the 39 works produced 33,535 tons of sulphate. There were two additional works; and the production was 1227 tons in excess of that of the previous year. The Inspector deals rather fully with this branch of his labours. In the course of his remarks, he says: The proportion of sulphate made by gas-works shows a large augmentation; while there is a falling off in that produced by private distillers. This is accounted for by the fact that most of the gas-works show an increased quantity of coal carbonized, and also that one large London works and two small provincial works, which have hitherto sold their liquor, have now erected and started sulphate plants of their own. Of the total quantity of sulphuretted hydrogen evolved in the process of the distillation of gas liquor for sulphate making, the very large proportion of 76·5 per cent. is burnt into sulphurous acid and utilized for the manufacture of sulphuric acid; 12·8 per cent. is burnt and allowed to escape into the air as sulphurous acid; 5·5 per cent. is absorbed in oxide of iron; and 5 per cent. is treated by the Claus sulphur-recovery process. The utilization of the sulphuretted hydrogen for sulphuric acid making has again been carried out most successfully; but the quantity burnt and allowed to escape into the air without recovery is far too large. The comparatively small quantity absorbed in oxide of iron—5·55 per cent. of the total production—represents that evolved from no less than 24 of the 39 works producing sulphate of ammonia; so that it is obvious that the majority of the small works resort to this method of dealing with the foul gases. It is undoubtedly the best and safest one to employ. In most of these works, the cooling and purifying space in use is sufficient; and, speaking generally, I have been well satisfied with the condition in which the purifiers have been found. Instances have occurred where they were found to be showing signs of exhaustion; but I have had no case where more than a word of caution has been required. The Claus sulphur-recovery process has been in operation at three works. Tests of the gases leaving the chambers have been made in all cases from time to time; and very variable results have again been shown. It seems an exceedingly difficult matter to adjust the air supply to the theoretical quantity required. At times the waste gases are almost harmless; but frequently comparatively large quantities of either sulphuretted hydrogen or sulphurous acid, or both together, are found escaping. In each case they are effectually absorbed in limestone towers and oxide purifiers. The most recently erected plant has been under very careful and constant supervision during the 20 months it has been working; and the results have been much more satisfactory than in the other two cases. At one works the use of lime for decomposing the fixed ammonia salts has been given up in favour of caustic soda. The cost of the latter, when considered in relation to the amount of work it is capable of doing, is less than that of lime; and its use has the further advantage of being more cleanly, with less probability of blockage in the liming vessel and overflow pipes, and the entire removal of the necessity of settling-pits for ridding the spent liquor of lime sludge. There can be little doubt that the substitution of caustic soda for lime would in many other cases lead to economy in time, trouble, and cost. The plant at many of the works has undergone renewals and improvements; and the two new sulphate works which have been registered are both provided with continuous stills and oxide of iron purifiers. The quantity of sulphate of ammonia made by the continuous method of distillation increases year by year; and it has now reached 97·2 per cent. of the total amount produced in the district.

As already mentioned, the statistics relating to Scotland are given in a separate section of the report. The number of works registered last year was 137, of which 16 were alkali works, and 121 were other works coming under the classes named in the Alkali Act. In those in which sulphate of ammonia is made, the production last year was as follows: Gas-liquor works, 11,306 tons; shale-works, 26,600 tons; iron-works, 5790 tons—total, 43,696 tons. The total for 1890 was 39,689 tons, made up as follows: Gas-liquor works, 10,395 tons; shale-works, 24,730 tons; iron-works, 4564 tons.

* The sulphate plant devised by Mr. Jervis was described and illustrated in the JOURNAL for March 27, 1888 (p. 553).

MOSSLEY CORPORATION GAS SUPPLY.

The Attack on the Chairman of the Gas Committee and the Gas Manager.

In the course of the brief notice of the proceedings at the meeting of the Mossley Town Council which appeared in the JOURNAL for the 24th ult. (at which meeting the annual accounts of the Gas Committee were submitted), mention was made of some insulting remarks which had been uttered by one of the members of the Council (Mr. Jones) concerning the Chairman of the Gas Committee (Alderman R. S. Buckley) and the Gas Manager (Mr. R. Merrell). Alderman Buckley and Mr. Mitchell on that occasion accused Mr. Jones of having used, and they were both ready to prove that he had used, the words "damned frauds" in reference to the Gas Manager and the Chairman, and also with having made use of an expression in relation to the gas-works and management as a "Hunter and Lever business." The matter came before the Gas Committee on the 6th inst., when they passed the following resolution: "That the members of the Gas Committee hereby express their entire disapproval of the scurrilous and unprovoked attack made by Councillor Jones on the character of Mr. Richard Merrell, the Gas Manager; this attack they believe to be perfectly groundless and uncalled for. They desire further to place on record their complete confidence in the honesty and integrity of their Manager." This vote of censure was included in the minutes, which were submitted by the Committee at the meeting of the Town Council last Thursday week. Referring to the matter, in moving the confirmation of the minutes, Alderman Buckley said that, if the remarks which had been made had concerned himself alone, the members would not have heard another word on the subject; but, coupled with the observations and attacks made, there was the name of their Gas Manager, who naturally felt very uncomfortable under the accusations. He (the Chairman) believed him to be a faithful, honest, and worthy public servant, and his character had been attacked not in the newspapers but by individuals in that neighbourhood—individuals in that Council. That being the case, he thought that, when those attacks were made, they had a right, and it was their duty to protect their servants, and at any rate to pass a resolution expressing their confidence in him. Mr. Merrell was very anxious, his family was anxious, and his brother gas managers all over the country were anxious about the

matter; and as the report had been carried the length and breadth o the land, they naturally expected some justification about the reports which had been made. There was no better justification than to pass the minutes of the Committee. There had been no attempt to withdraw anything on Mr. Jones's part, and no attempt to apologise after being asked to do so; had he done so, no doubt the matter would have ended. Mr. Jones requested Alderman Buckley to state what constituted the scurrilous and unprovoked attack. Alderman Buckley replied that the first words he had used were that the Chairman and Manager were "damned frauds." Mr. Jones denied that he had used that expression; but Alderman Buckley told him there was ample proof that he did employ it. Then at a recent meeting in the Corporation offices, he had made use of the words: "There is no Hunter and Lever business about me." He would leave the Council to judge what was the occasion for the use of these words. An amendment was moved by Mr. Clementson to the effect that the resolution referring to Mr. Jones should be deleted, and the following resolution, which he had himself proposed at the meeting of the Gas Committee, but which was not then agreed to, should be inserted in its place: "That this meeting pass a vote of confidence in the Gas Manager for his honesty, straightforwardness, and good qualities as Gas Manager, and that the Committee have every confidence in him, notwithstanding the adverse statements made in some of the papers." The Town Clerk intimated that they could not substitute one motion for another, without referring it back to the Committee; and Mr. Clementson then altered his amendment to read: "That the minutes pass with the exception of the motion made by Alderman R. S. Buckley." Mr. Jones said, now it was defined as to whom his observations were said to apply, he desired to state to the Council that, when he made those statements at the general meeting on May 9, they did not refer to the Manager of the gas-works; and, therefore, he did not, nor had he any desire to, cast any aspersion on the conduct or character of Mr. Merrell. Mr. Mitchell strongly urged the Council to protect the Gas Manager, and to pass the resolution. Alderman Buckley having replied, the amendment was put to the vote and lost, and the motion was carried by a large majority. Since this meeting Mr. Jones has addressed a letter to a local newspaper, in which he compares the working of the Mossley and the Stalybridge gas undertakings; but, whatever the results may be, they cannot justify the language used by him as recorded above.

BINGLEY IMPROVEMENT COMMISSIONERS' GAS SUPPLY.

Annual Statement—Reduction in Price.

In moving the adoption of the minutes of the Gas Committee at the meeting of the Bingley Improvement Commissioners yesterday week, Mr. Gatecliff, the Chairman, made a statement giving a comparison of the results of the operations of the gas-works during the past two years, and also of the condition of the works in 1875 and at the present time. The gas produced in 1891 was 57,452,500 cubic feet, and in 1892 57,084,300 feet; while the amount sold was 53,264,200 and 53,968,200 feet respectively. The receipts from gas in 1891 were £8755; and in 1892, £9342. The profit in the first-named year amounted to £491; and last year to £726. The Committee proposed a reduction of 2d. per 1000 cubic feet; but they did not think it advisable that it should apply to the outside districts. These districts consumed 30 per cent. of the total amount of gas made; and if charged according to the average cost of mains and consumption of gas, they would proportionately pay 5s. 1d. per 1000 feet, against 3s. 4d. by the consumers within the Commissioners' district. The estimated profit for the present year was about £490, which would be sufficiently large to allow of the reduction. Turning to the condition of the gas-works in 1875, Mr. Gatecliff said that the value of the gas plant was then £18,000; the capital sunk, £49,507; the length of mains, 10 miles; the gas made, 32,318,200 cubic feet; the average price, 4s. 9d., with 5 per cent. discount; the amount of interest paid, £1763; the amount of sinking fund, £904; the gross profit, £564, or a loss of £340. In 1892 the gas plant was valued at £36,510; the capital employed was £26,131; the length of mains, 23 miles; the amount of gas made, 57,084,300 cubic feet; the price, 3s. 4d. per 1000 feet, with 15, 17, and 20 per cent. discount (gas for cooking and heating purposes being sold at 2s. 4d. per 1000 feet net); the interest paid, £1076; the amount of sinking fund, £1166; and the net profits, £726. Since 1875, besides paying interest on the capital, the gas-works had raised toward the rates and in reduction of capital a sum of £32,222. He thought if the undertaking continued to prosper as much during the next twelve or thirteen years, they would have plant valued at £40,000, the whole of the capital would be paid off, and they would be able to reduce the price of gas 1s. per 1000 cubic feet, and allow 15 per cent. discount. The minutes were duly adopted.

Sale of Shares.—Mr. H. Warren lately offered for sale by auction at Winchester £2500 of additional nominal capital in the *Winchester Gas and Water Company*, divided into 100 shares of £25 each, the dividend on which will not exceed 7 per cent. The amount realized was £3947 10s.; the average price per share being £39 9s. 6d.

Newcastle (Staffs.) Corporation Gas Supply.—At the last monthly meeting of the Newcastle (Staffs.) Town Council, the Management Committee recommended that £1350 be paid out of the profits of the department to the Urban Sanitary Authority. The Mayor (Mr. W. O. Briggs), in moving the confirmation of the minutes of the Committee, said there had been a moderate but steady increase in the business. The augmentation in the quantity of gas supplied had not been so large as in the previous year; but they had not had such a severe winter. There had also been a steady advance in the price of residuals. The expenditure for coal and purifying materials had been heavier, and labour had cost more. With regard to the last point, his Worship mentioned that two years ago the Council decided to increase the scale of pay; and the effect had been to raise the amount paid during the past year by nearly £200. After providing for payment of the interest on the bonds and income-tax, and also discharging their annual payment to the sinking fund, there was available for distribution £1518, as against £1448 in the preceding year. The minutes were confirmed.

LONDON COUNTY COUNCIL.

Electric Lighting of the Embankment—London Water Supply.

At the Meeting of the London County Council last Tuesday, the Highways Committee presented a report on the proposal to substitute electricity for gas in the illumination of the Thames Embankment. They recommended that it be referred to the Highways Committee to carry out, at a cost not exceeding £10,000, an electric installation, with the necessary plant for the lighting of the carriage roads, footways, and parapet wall of the Victoria Embankment. The consideration of the matter was adjourned for a week. On the same occasion, the Special Water Committee reported that, the Royal Commission on the Metropolitan Water Supply having expressed a wish to be furnished with some indication of the views of the Council on the subject of the inquiry, a memorandum had been prepared by the Deputy-Chairman of the Council and carefully considered by the Committee in conference with him. It was based on resolutions passed by them after due consideration of tables prepared by the Engineer (Mr. A. R. Binnie, M.Inst.C.E.) with reference (*a*) to the number of years upon which estimates, having regard to the future water supply of London, should be based; (*b*) the population for which provision should be made; and (*c*) the quantity of water which should be supplied per head per day. The views which they entertained on these points would, no doubt have greater weight with the Commission if the matter were considered by the Council. They therefore recommended the Council to confirm and adopt the following opinions and conclusions expressed therein: "(1) That, in making any estimates having reference to the future water supply of London, such estimates should be based on a period of 50 years from the present time; (2) that, in dealing with the question of a source or sources of water which shall meet the requirements of London and its neighbourhood for 50 years, provision should be made for supplying a population of at least 12,500,000; (3) that, in calculating the quantity of water required per head per day, the amount at present supplied by the Companies should be increased by at least 10 per cent., and in no case should it be less than 35 gallons." The recommendation was agreed to.

THE ELECTRIC LIGHTING QUESTION AT WORCESTER.

The Worcester City Council, at their last meeting, had a further debate on the question of electric lighting; but it appears that they are still undecided as to the extent of the proposed installation. Alderman Hill moved a resolution in favour of accepting the tender of the Brush Electrical Engineering Company, subject to obtaining the sanction of the Local Government Board; but delaying the actual settlement of the contract pending the receipt of a report from the Watch Committee as to the proportions which should be accepted, and especially as to (1) whether provision should be made for steam power only, or steam power and water power combined; and (2) the provision to be made for street lighting. In the course of his remarks in support of the motion, Alderman Hill stated that, if street lighting were undertaken, the extreme cost of the Brush system would be £22,680; and they would get a production of 450,000 volts. In the case of the Electrical Storeage Power Company, the cost would be £23,699; and the production, 396,000 volts. The motion was seconded; and then Mr. Millington questioned the impartiality of their electrical adviser (Mr. Preece), who, he alleged, had been exceedingly careful to state everything he possibly could in favour of the Brush Company; but had been just as careful to omit to state things in favour of the Electrical Power Storeage Company. During their visit to Bath, the members of the Council did not see an electric light. They only saw a dirty, greasy station; and there they found five or six engines doing nothing. At Bournemouth the members certainly saw a pretty little station; but he believed the engineer in charge left there about two months ago, really because he was tired of complaints, and was continually worried. He pointed out that the Committee had not applied to corporations for information with regard to the light, but to private companies. They obtained some particulars from Bournemouth, but that was practically the Brush Company, who were also interested in the works at Bath; and it was not at all likely that they would stultify themselves in the information they gave. Mr. Corbett, Alderman Airey, and Mr. Chaplin opposed the motion; the last named gentleman remarking that they ought to accept the tender of the Electrical Power Company, as their system was safe, and could be worked in an economical manner. Alderman Day expressed the opinion that the lighting at Bournemouth was extremely good; and as to the installation at Bath, the members visited the station at midday, when it was not necessary for the machinery to be at work. Mr. Wood said he should vote against the motion, on the ground that it appeared to him to be probable that the scheme, instead of being a source of revenue, would cause considerable loss for many years to come. On the motion being put to the vote, 28 members declared in favour of it and 10 against it. A meeting of the Watch Committee has since been held, at which it was referred to a Sub-Committee to consider and report as to which portions of the work should be proceeded with.

The Purchase of the Ipswich Water-Works.—A special meeting of the Ipswich Town Council was held last Tuesday, to receive a report notifying that the Bill promoted by the Corporation for the purpose of empowering them to acquire the water-works had received the Royal Assent. Arrangements, it was stated, had been made with Messrs. Gurneys, Alexander, and Co. to issue the stock at a price within the limit mentioned in the last report of the Committee (see *ante*, p. 1133), subject to the passing of formal resolutions by the Council. These sanctioned the creating of stock, in two sums of £213,700 and £1350; the minimum price to be 95 per cent., the dividend to be at the rate of 3 per cent. per annum, and the first dividend to be paid on Dec. 23. The sum of £213,700 will be redeemable in 1952, and the £1350 in 1907. The resolutions were agreed to; and a Water-Works Management Committee was appointed.

THE METROPOLITAN WATER SUPPLY COMMISSION.

Monday, June 20.

(*Lord* BALFOUR OF BURLEIGH, *Chairman; Sir* G. B. BRUCE, *Sir* A. GEIKIE, F.R.S., *Professor* DEWAR, F.R.S., *Mr.* G. H. HILL, M.Inst.C.E., *Mr.* J. MANSERGH, M.Inst.C.E., *and Dr.* W. OGLE, *Commissioners.*)

On the re-assembling of the Commission to-day, further evidence was given as to the River Thames.

Mr. *G. J. Symons*, F.R.S., was the first witness called. He said he had devoted a great deal of time and research to studying the rainfall over the watershed of the Thames; and not merely the Thames, but of the country generally. He put in a statement upon the rainfall over the Thames and Lea; mentioning that the very large area of the watershed of the former river and the immense number of rainfall records which had been kept within it rendered it necessary to find some mode of giving the results in a compact form. After much consideration, he had adopted a method in which the values quoted rested upon 10 consecutive years' observations, and in which nearly all were not merely the average of 10 years, but of a 10 years of which the average represented very closely that of 40 years—that was to say, the ten years chosen were neither a dry nor a wet period. In the first table in the statement was given the mean rainfall during the consecutive years from 1850 to 1889 at ten widely-spread stations; and in subsequent columns, the averages of their ratios to the 40 years' means for the same stations for three different groups of years. The period from 1860 to 1865 was quoted, because it was the first for which anything like a trustworthy average could be given for the whole country; and it was to be seen that, excepting Sussex, the ratios were low. The average of all was 97; therefore this period had 3 per cent. less than the average of the 40 years already mentioned. To put it in another form, during the six-year period there was annually about an inch less rain over the Thames watershed than during the average of the 40 years. Witness supplemented the explanations in his statement of the three tables—viz., Table I., which represented the relation of the rainfall in various periods to the mean of the 40 years from 1850 to 1889; Table II., which gave the mean rainfall at 145 stations in and adjacent to the watershed of the Thames and its affluents above the Nore; and Table III., which stated the fluctuation of rainfall in the Thames watershed.

In reply to Sir A. GEIKIE, witness stated that the heavy rainfalls were, as a rule, very local, and that the greatest rainfalls came down during thunderstorms. In such cases, over a small area—perhaps 1 miles square—they might have up to 3 inches in a couple of hours; if the fall came over the whole basin of the Thames, it was not often they had more than 1 inch in 24 hours. But he had not looked specially into this for the purposes of the inquiry.

Dr. *A. Ashby*, Medical Officer of Health for the borough of Reading, next gave evidence. His investigations for the purposes of the inquiry were, he explained, confined to the Thames and its tributaries between Hampton and Oxford; and, referring particularly to Oxford, Uxbridge, and Watford, he stated that he found much pollution. At Uxbridge, the effluent, even when diluted with river water, was very offensive. The sewage was delivered under water. He took a sample of it mixed with the river water, and sent it to a chemist; but he had not yet received the analysis. At Oxford, he found the effluent very foul; and the bed of the stream into which it went very bad indeed. At Watford the effluent went off into the river, likewise in a very foul condition; and there was a large deposit of offensive sludge in the bed of the river. Questioned as to the tests he applied, witness remarked that what he saw and smelt was quite sufficient, as far as he was concerned, to make known the character of the effluent. It was excessively foul, and gave forth a very offensive odour. These pollutions, he allowed, might be less on some occasions than on others; but he was fully persuaded that they were of a permanent kind, and that what he saw was a fair average of what was continually to be seen. Where the foul deposits in the streams remained for some time, there was great danger to the community. Further, he considered that no amount of supervision, without permanent works to remedy this state of affairs, would get rid of the danger.

The CHAIRMAN requested the witness to explain what pollutions he regarded as absolutely dangerous to health, and which might be classified as not dangerous—only nasty.

Witness said there was no doubt that, where human excreta were discharged into the sewers, there was most danger. From slop pollutions there was, as a rule, less; though he could not consider there was no danger from this. Being requested to say whether laundries, tanneries, fellmongers' yards, breweries, and paper-mills were inimical to health, witness added that he thought the tanneries and the fellmongers' yards were the most dangerous; and he likewise observed that the effect of the flow of a river on pollutions could not be relied upon to get rid of the danger from them.

The CHAIRMAN remarked that the witness, in his statement sent in, did not give the Commissioners any details about the effluent from the Reading sewage farm.

Witness said, as a rule, it was very fair. Of course, at times there were more or less impure emissions from it.

You have an opportunity of seeing that constantly. What is the worst you can say of it?—I think I may say of it the same as might be said of any sewage farm—that there may be times when there is not the purest effluent, when more or less impure matter goes out.

Is the result of your experience this—that no sewage farm is so perfect as to make it right for populations to use, as drinking water, a stream into which the effluent of the farm goes?—I think there is danger in the effluents from all sewage farms.

Is your opinion this, if you think it fair to express one, that the populations on the upper reaches of a river should be prevented from putting anything into it to pollute it, or that the lower populations should cease to use it as a water supply?—I think the right use for a river is, besides being a waterway for pleasure boats and for barges, to receive the sewage from places on it after the sewage is treated as perfectly as possible.

Then it is rather that Reading should pollute the river than that London should drink out of it?—That Reading should do the best not to foul the river, but should have the right to send its purified sewage into it.

The same would apply to the streams above the intake of the Reading Water-Works?—Yes.

Do you think Reading should continue to use Thames water?—I have expressed an opinion about that; but it has not been taken.

Questioned regarding the number of house-boats on the Thames, and as to a discrepancy between his written statement and that of the Thames Conservancy on the subject, witness said his source of information was very reliable, though private; and he put the number of the house-boats down as 240, and the number of steam-launches as 646. The Conservancy stated that the former numbered 167; and the latter, 393. Generally, he added, there were now no water-closets on the house-boats—they had earth-closets; but he could not believe that the contents of these were always deposited on shore. The temptation to get rid of refuse in the easiest and readiest way was, with the majority of people, too great for that.

In reply to Sir G. B. BRUCE, witness gave it as his opinion that works of sewage purification might be carried out so as to make the effluent perfectly fit to go into a river; but so much depended upon continual care, that he could not help thinking there must, even then, be times when the effluent was of a character to make it undesirable to take a water supply from the stream into which it went. Moreover, he looked upon the character of a water supply as upon that of a chain. The strength of a chain depended upon its weakest link; so a water supply should be judged at its worst, or in the circumstances of its greatest danger.

You are Medical Officer of Health for Reading. Have you any tangible evidence of injury to the inhabitants of the borough owing to their drinking the water with which they are supplied?—No; I have not.

Comparing, at the instance of Sir G. B. BRUCE, the effluent at Oxford with that at Reading, and referring to the treatment of the sewage at both places, witness pointed out that in that treatment a great deal depended upon the nature of the land where it was carried on. One piece of land might, he said, produce a purer effluent than another.

Sir G. B. BRUCE: But you consider that the water of no river which receives the drainage of towns or on which people live ought to be used for drinking?

Witness: I think it is undesirable, and what I should call unsafe.

The unsafeness of which you speak is not based upon your experience, is it, but is a theory?—There are instances where the use of river water for drinking has spread disease.

In reply to Mr. HILL, witness stated that he had no information as to the death-rate of the various places mentioned in his statement sent in, as he was not charged with inquiring into the sanitary condition of the places themselves. Of course, the sewage farms might be very excellent things for the towns that had them; and no doubt Oxford, and Reading too, had immensely benefited by their sewerage systems. Yet there was room for still greater improvement at these, as well as the other places he had visited.

Interrogated by Dr. OGLE, witness admitted that some of the pollutions to which he had referred in the statement he had sent in were excessively slight; but he explained that his statement gave the minimum amount of pollution of the Thames, because, from the nature of the investigations he had made, it must have happened that some sources of pollution had been overlooked by him. There was danger to health from taking a water supply from a stream that was polluted by cattle. At the same time, he had no evidence, nor had he read any, of fever or disease being propagated through the drinking of water polluted in this way. But the possibility of it was a matter which ought to be borne in mind when they were dealing with questions of water supply. Further, it was difficult, if not impossible, to say that streams on the borders of which populations resided were polluted only by cattle. There was always a chance of human excreta reaching them.

In answer to Sir A. GEIKIE, witness mentioned that he undertook the examination, the results of which he had given to the Commission, at the instance of the London County Council.

The CHAIRMAN asked if he was to take it as the opinion of the witness that it was impossible so to purify the Thames as to make it a safe source of water supply for the populations on its banks.

Witness replied that there were so many chances of pollutions of rivers that, with the best precautions and control, he could not think they were very safe sources of water supply.

Dr. *G. H. Fosbroke*, Medical Officer of Health for the County of Worcester, gave the results of an examination by him of the Thames above Oxford. They went to show that, in the upper basin of the river, the substratum was very porous, and allowed of much of the sewage soaking through; but that some of the places where the sewage was disposed of were near the Thames, and so were conjectural sources of pollution.

At the close of this witness's evidence,

The CHAIRMAN remarked that what had been stated would have the most careful consideration by the Commissioners, and that perhaps local investigation at their instance would follow.

The Commissioners then adjourned till the next day.

Tuesday, June 21.

Dr. *E. Frankland*, F.R.S., was the first witness called to-day. In answer to the CHAIRMAN, he said that, although he appeared to give evidence at the request of the London County Council, the views he desired to express were entirely his own private opinions, and the Council were not at all responsible for them. Last year, when the Council were promoting a Bill in Parliament to enable them to treat with the London Water Companies in order to deal with the question of the water supply, they requested him to undertake a series of analyses on the Rivers Thames and Lea above the Companies' intakes, and also of the waters as delivered in London. The investigation he made was more complete, and more frequently repeated, than the one he conducted for the Local Government Board; his observations and analyses extending over a period of six weeks in the spring of last year. He had been requested at that time to draw up a proof, to be

placed before the Parliamentary Committee; but as the Committee declined to go into any question of quality, he was not examined on the point. The opinions he was prepared to give to the Commission would be based upon the information gained at that time, in addition to particulars to be gathered from a series of analyses made by Mr. Dibdin, the Chemist of the London County Council.

Professor DEWAR: With regard to the drainage of manured land and the effluents from sewage works, and even raw sewage itself, have you recently had any occasion to observe the character of the sewage effluents passing into the Thames?

Witness: I have had no opportunity of examining, as far as I remember, any sewage effluent passing into the Thames, of late years.

So that you are not conversant with the sewage treatment of the different areas, and whether it has been effective or ineffective?—No. There is found in water a great deal of animal matter which is generally innocuous, but is, I think, sentimentally objectionable. The drinking of liquid which has formed part of sewage, although it might be altered chemically to a considerable extent, might be occasionally dangerous, from the presence of zymotic disease amongst the persons contributing to the sewage.

Questioned as to whether he had considered the probability of pathogenetic germs being in the water delivered in London, witness said that at the present time he was engaged in a series of observations which would, he hoped, throw more light upon the subject. It was a point which still required a considerable amount of investigation. Of course, if they had any process of filtration which would remove every germ from the water, this would be almost an absolute safeguard; and there would then only be the sentimental objection. He had recently experimented on the water as it issued from the filters of the various London Water Companies drawing from the Thames and Lea; and he confessed that he had been somewhat astonished at the result. Instead of getting hundreds of microbe germs per cubic centimetre, he found in some cases only 4, and the maximum was only 24. These observations had only been made once; and it remained to be seen whether further investigations would confirm this result. It was obvious that the safeguard of filtration depended upon the number of microbes passing the filter-beds. At the same time, a single germ which passed through might multiply enormously, and affect the water flowing in the mains of London. There was no doubt that the germs did multiply in this way. If, however, many thousands, or tens of thousands, of microbes or their germs were removed from water, leaving only one, or even four, it was extremely unlikely that amongst those four there would be a pathogenetic germ.

Professor DEWAR: The amount of purification with regard to these microbe organisms reaches 88 or 89 per cent., does it not?

Witness: Yes; about that.

Assume that it reaches (say) 98 per cent., have you considered, as a mere question of probability, providing these two were specific organisms of an objectionable kind, what would be the chances of their escaping?—I should think, apart altogether from the possibility of after-development, the chances of their getting through the filter would be very small.

Have you yourself made any attempt to distinguish between the pathogenetic germs and the harmless germs in London water?—No; I have been rather deterred from doing so from the fact that an exhaustive examination has failed to distinguish between them. At the time of the Rivers Pollution Commission, it was considered that only suspended impurities would be removed by filtration, and from 20 to 30 per cent. of the organic matter in solution. It has only in recent years been discovered that sand filtration removes from 70 to 80 per cent. of the organisms present.

If the Royal Commission in 1874 had had the knowledge with regard to the filtration of water and the general characteristics of those microbe organisms, would their report have been quite so severe as it was?—No; I do not think it would. The recent discoveries in connection with filtration have very considerably modified my own opinion, and I have no doubt that of others also, with reference to the value of filtration, and its security. There have been a number of very remarkable outbreaks of disease which have been traced to impure water, especially at Zurich, in Switzerland. At Lausanne a case occurred where water was supplied to the community from a spring after making its way through the moraine of a glacier, and passing a mile or two of fine sand. After some very careful experiments, it was found that the water in a neighbouring valley, where typhoid fever had occurred, re-appeared at the spring in Lausanne. This was proved by dissolving several hundredweight of common salt in the water in the valley, which rendered the water in the Lausanne spring salt. The experiment was then tried with flour carefully mixed with water; but not a trace of the flour re-appeared, as the very fine starch granules had been filtered out of the water. The starch granules which the filtration there was sufficiently good to remove were, of course, larger than microbes, but they were very small indeed.

Can you give us any instance of river water (water that has been stored and subsequently filtered artificially) doing anything equivalent in the way of communicating disease?—No; neither do I believe that there is an instance to be found, because I have carefully searched for it. I can give an instance of what, in all probability, was the propogation of cholera from one town to another upon a river, when the river water was not stored. I presume it was filtered, although I am not sure about it. The case was that of Sheffield and Doncaster, on the River Don. The cholera outbreak in Sheffield preceded that in Doncaster. The sewers—six or seven of them—discharged into the Don, and the people drank the water. The cholera occurred at Doncaster when it might have been expected, assuming the poisoning to have been communicated by the agency of the river.

Mr. MANSERGH: Do you happen to know if there was an outbreak of cholera in Rotherham three or four miles from Sheffield?—I think there was.

Professor DEWAR: Is not a very small change in the environment absolutely destructive of a large proportion of these minute microbe organisms?

Witness: Yes. In a flowing river, where the environment is never constant, the conditions would be very fatal to the life of the organisms. Experiments have been made with pathogenetic organisms; and it has been found that they would live in river and other waters, some as long as 114 or 116 days. These would probably be the spores. The amount of knowledge on the subject is very contradictory, and very incomplete; and people are only just beginning to know something definite about these organisms.

In answer to further questions, witness said no experiments had been tried upon a flowing river, except with regard to the inferential proof that the organisms have been carried a long distance, as it was, of course, difficult in a laboratory to imitate a flowing river. Several important trials had been made to ascertain whether the presence of other organisms was fatal, or not at all healthful, to the life of a small proportion—say, 2 per cent.—of the dangerous microbes; and from them it was found that such dangerous organisms frequently fall a prey to the harmless ones. There was always present in water a very large number of harmless organisms. The continuous change in environment in a river, together with the exposure to light, the variations in suspended matter, and precipitations going on, all tended to be fatal to the life of one or two specific organisms; and when to this was superadded filtration, the probabilities perhaps would be against these organisms occurring, though it by no means excluded the possibility. Asked if he recommended that increased storeage should be compulsory on the Water Companies, witness said this was a very difficult question. Sometimes the storeage was really an evil. A very much greater quantity was required than any Company possessed. The flood water must be taken into the reservoirs, and then sent on to London and distributed among the consumers; and he believed it could not be got rid of. Consequently, it frequently happened that a Company which had a great extent of storeage had not such good water as others who had less, because immediately after a flood the water became very good; and this the smaller companies, having less water to deal with, were able to take in. It was a very difficult matter, therefore, to say that it was a good thing to have a large storeage or a small quantity of storeage; but he thought a fair amount—say, for 10 or 15 days—was desirable. If he could advise, without any reference to practicability, he should say that each Water Company should have sufficient storeage to tide over the longest flood. This, however, he did not think was practicable, as the flood waters came down the Thames for a period extending to 30 or 35 days. As a general rule, although there might be some exceptions to it, those Companies who had the best storeage delivered the best water.

Sir A. GEIKIE: Have you given any attention to the effect of storing water upon the propagation of the microbe organisms?

Witness: Only in the laboratory. I find that water which contained a large number of microbe organisms when it came out of the river would be almost sterile in the course of a week or ten days.

In answer to further questions, witness said there was no doubt at present that there was very great difficulty in supplying the Water Companies with gravel. The population was very sparsely distributed at that portion of the banks of the Thames from which the water came; but it was, he presumed, gradually extending. Between 1868 and 1873, and also in 1891, London water had deteriorated in respect of the organic matter held in solution. This, he thought, could only be explained by an increased population, and the passage into the Thames of sewage effluents from chemical and irrigation processes more quickly and in larger quantities than formerly.

Professor DEWAR: In spite of the large amount of work that has been done by the Thames Conservancy in inducing these populations to construct sewage works, which did not exist in 1868 or 1873, the river had deteriorated in 1891?

Witness said the presence of a greater quantity of dissolved organic matter had made it worse. It could not, he thought, have deteriorated in regard to other objectionable products in suspension. There could be no doubt that the river had been greatly improved in this respect by the Thames Conservancy.

Further questioned by Professor DEWAR, witness said he had analyzed a number of samples of water for the Commission, and these he had compared with the series he made last year. These samples were taken at different times of the year, when the river was in a fairly good condition, there being no flood. There was a very considerable variation—organic carbon rising to 0·403 per cent.; and water containing this amount of organic carbon he regarded as unfit for a domestic supply. He would not go so far as to say that such water was not capable of being satisfactorily treated by filtration, and subsequently distributed for domestic use; but it would require a long subsidence and very careful treatment, and the water would probably then be coloured.

Professor DEWAR: Can a river like the Thames, which receives treated sewage, be made into a perfectly safe water supply?

Witness: I should not like to say that there is sufficient safety in the operations to which it is subjected before delivery to make it a perfectly safe water for drinking purposes. London has already suffered very severely from illness owing to the propagation—in some cases by water—of animal disease.

Where would you go to get a supply that would be satisfactory?—To the springs in the Thames basin, and to deep wells in the chalk and the oolite, in which, I believe, there is not a single organism, though this remains to be proved.

In further examination, witness said he thought, as to the river itself, no improvement could be effected by going to any source higher than Hampton. At Staines the organic carbon and organic nitrogen were less than at Windsor. The river between Lechlade and Hampton differed very little in composition. He could not say that the tributaries of the Thames had deteriorated. It was a mere matter of chance what the condition of these rivers would be on any two occasions when samples were taken. Probably the state of the tributaries was very much the same as that of the Thames itself. The Colne was much better now than it had been. Taking all the figures together, he drew the conclusion that there had been very little change in the Thames, so far as analyses went, between 1868 and 1891; but the water as delivered for consumption was greatly improved. Asked if he had any suggestions to make as to the improvement of the present supply, he said that he would recommend the pumping of a larger quantity of water from the gravel, instead of taking it from the river, and also the sinking of deep wells

and bore-holes, which had been successful, in some cases, in bringing to the surface water of a very excellent quality. Taking the raw material as it came to the Company's intakes, and considering the way in which it was then treated by filtration, he did not think it could be done better than it was at present. The artificial softening of the water by Clark's method would be an improvement. He had, however, serious doubts as to whether it could be done on the enormous scale that would be necessary for London. It was carried out at one or two places, such as Bushey, but on a very much smaller scale than would be necessary with the Thames. With regard to the increased organic matter present in the water in 1891, there was no doubt it was connected in some way with the excessive fogs prevalent at that time; but how the impurities contrived to pass the filter-beds and to affect the water in the way they did, was very difficult to say. The River Lea had never been so much polluted as the Thames; and in 1891 the increase was proportionately less. He thought that for the next hundred years there would be no need to go outside the Thames basin for a good supply, as there was no place so rich in excellent water as this. It would become a question, if water was at any time taken from the chalk, as to whether it would cost more to do this than to bring it from a single source—Wales or Cumberland, for instance.

Questioned by Sir A. GEIKIE, witness said the chalk was a sort of sponge, which absorbed a large quantity of water, and heaped it up, as it were, in the chalk downs at a very considerable elevation above the river levels. The water was thus kept for a long time until the chalk was surcharged with water, when it very rapidly passed into the streams and was lost among the flood water. If, by sinking deep wells in the chalk, or by other means, the water was depleted, the rain water as it fell and was absorbed would be available. In that way, he imagined, a good deal more water could be obtained from the chalk stratum than by merely utilizing the springs as they now issued from the chalk. Oolite did not act as a sponge; but he believed there were a great number of fissures and cavities in it in which a large quantity of water was stored. Taking the springs in the Thames basin which he had himself investigated, he estimated their normal flow at between 70,000,000 and 80,000,000 gallons daily. He had contemplated, when saying that there was an ample supply of water in the Thames basin for a hundred years, the driving of a series of galleries into the chalk and the oolite. There would, however, be the objection to the scheme, that all the water would have to be pumped twice over—first out of the wells, and then into the mains.

By Mr. HILL: His own scheme was for the construction of storeage reservoirs in the Thames basin; and the water thus collected from the springs would be brought down from the Companies' respective works. The direct consumption of this water would, no doubt, have an effect upon the streams; and in some cases the stream might be dried up. He did not think, however, that the surface of the ground would be affected for agricultural purposes.

Mr. MANSERGH asked witness if there had been any epidemic produced by London water since 1854.

Witness replied that in 1866 there was one which was attributed by Dr. Parr and others to an infected supply of the East London Water Company at the time. With regard to the microbes, a temperature of 75° C. would very soon destroy them; but the spores, which were the half-developed microbes, would sometimes stand boiling for five hours without being destroyed. This was the reason why, in their investigations, they required three days to sterilize any substance. If a true view of the composition of the average Thames water, as used for consumption, was required, he thought daily samples ought to be taken for at least a month, and even longer than that. Considering the rapid progress that was being made in researches, he was of opinion that, in another twelve months, they would be in possession of further useful information.

Dr. OGLE: It is uncertain how far the numerous cases of zymotic disease occurring in the Metropolis are traceable to the water?

Witness: Yes. There is no evidence that diseases like measles, scarlet fever, and whooping-cough are propagated in this way. The zymotic diseases to which I have referred are cholera and typhoid fever. I think these are the only two diseases which have been known to be communicated through water. It is very likely that water containing cholera microbes would lose them after passing for some distance down the river.

Might we not suppose that the danger of London being infected by cholera owing to there being cholera higher up in the Thames or Lea valleys, would be very small?—I think that probably the evidence tends in that direction; but I believe it would be very unwise to drink water from those rivers at such a time.

I have a list, taken from the Registrar-General's report, of the deaths occurring from typhoid fever during six years in the Lea Valley; and the average is 22·6 in a year—the maximum number in one year being 27. Taking the amount of water that flows down the Lea Valley, and adding to it the quantity delivered by the New River Company, and supposing that the water was polluted in all those cases, I find that to each instance of pollution there would be used a body of water three miles long, two miles wide, and six feet deep. Does not that diminish the risk of infection so much that it may be practically dismissed? I am taking into account the fact that 98 per cent. of the bacteria would be removed by filtration.—I certainly think that the filtration would reduce the danger, and make it exceedingly improbable that any considerable number of people, at all events, would be affected; but if a single individual imbibed a single germ, I suppose it might be as bad for him as if he had imbibed a hundred.

Is it your belief that, if a person swallowed a single bacillus, he would necessarily suffer from the disease? Would not a certain number be required, and would not one be very liable to be destroyed?—I suppose one may be; but then the one might first have multiplied to a thousand.

If, however, you put the two chances together—the chance of swallowing the bacillus and the chance of harm being incurred thereby—there is not much danger, is there?—I should not like to go so far as that. I think it very unlikely that the disease could be propagated, if the water were sufficiently filtered. Of course, the number of microbes varies very much indeed in rivers. I do not think that the fact that thousands of people who drink the water from these sources suffer very little from typhoid fever is conclusive evidence that the water is wholesome.

In answer to further questions, witness said there was no direct evidence that typhoid fever had in some cases been communicated by water. If the Lea were exceptionally polluted by typhoid sewage, there ought to be a difference in the number of cases of typhoid fever occurring; but he was not aware of anything of the kind having been traced. The lowering of the death-rate for typhoid fever and the improvement of the water supply had been coincident. Of course, the water might pass through a second filter; and this might reduce the number of microbes.

The Commission then adjourned.

METROPOLIS WATER SUPPLY.

The Quality of the Water in May.

The returns furnished to the Registrar-General by the London Water Companies as to the water supply of the Metropolis during the past month, show that the average daily supply was 188,458,526 gallons, as compared with 179,908,849 gallons in the corresponding month of 1891; being at the rate of 240 gallons to each service. Of the entire bulk of water sent out, 95,280,334 gallons were drawn from the Thames, and 93,178,192 gallons from the Lea and other sources. Reporting upon the quality of the supply, Dr. E. Frankland said: "Taking the average amount of organic impurity contained in a given volume of the Kent Company's water during the nine years ending December, 1876, as unity the proportional amount contained in an equal volume of water supplied by each of the Metropolitan Water Companies and by the Tottenham Local Board of Health was: Kent, 0·6; New River and Colne Valley, 1·1; Tottenham and East London (deep-well), 1·3; East London (river supply), 1·9; Chelsea, 2·1; West Middlesex and Grand Junction, 2·2; Lambeth, 2·3; and Southwark, 2·5. The untreated river waters gave the following numbers: New River cut, 1·5; River Lea at the East London Company's intake, 2·9; and Thames at Hampton, 3·4. The water abstracted from the Thames by the Chelsea, West Middlesex, Southwark, Grand Junction, and Lambeth Companies was again, for river water, of a high degree of organic purity, being even superior, in this respect, to the samples drawn in April. It consisted, in fact, principally of spring water discharged from the chalk and oolite. It was efficiently filtered before delivery. The water taken chiefly from the Lea by the New River Company again ranked with the deep-well waters in respect of organic purity; while that supplied from the same source, but lower down the stream, by the East London Company, was superior to the best of the Thames waters. Both supplies were efficiently filtered. The deep-well waters of the Kent, Colne Valley, and East London Companies, and of the Tottenham Local Board of Health, were of excellent quality for dietetic use; that of the Kent Company being especially distinguished for its very high degree of organic purity. The Colne Valley Company's water, having been softened before delivery, was rendered suitable for washing. All these waters were clear and bright without filtration. Seen through a stratum two feet deep, the Kent, Colne Valley, Tottenham, and East London (deep-well) waters were clear and colourless; the New River, clear and nearly colourless; while the remaining waters were clear and very pale yellow. The crude river waters presented the following appearances: New River cut, turbid and very pale yellow; the Lea at the East London Company's intake and the Thames at Hampton, turbid and pale yellow. The bacteriological examination of the waters as they left the filters of the various Companies by Dr. Koch's process of gelatine plate culture, gave the following results: One cubic centimetre of each water collected on May 20 and 21 developed the following numbers of colonies of microbes: West Middlesex and Lambeth, 4; Southwark, 8; New River and East London, 10; Chelsea, 12; and Grand Junction, 24. Of the untreated river waters, one cubic centimetre of the water from the New River cut developed 158, the Thames at Hampton 631, and the Lea at the intake of the East London Company 4526 colonies of microbes.

Messrs. Crookes and Odling, in the course of their report to the Official Water Examiner for the Metropolis (General A. de Courcy Scott) on the quality of the water supplied by the London Water Companies in the past month, as shown by samples taken daily for analysis, say: Of the 182 samples examined, three were found to be very slightly turbid; the remainder being clear, bright, and well filtered. The character of the water supply to the Metropolis during the month of May was not found to differ appreciably from that manifested during the two or three months preceding. The proportion of organic matter present in the water—noticeably low throughout—was found to be just a little higher in the March supply than in that of February, but lower again in that of April, and still lower in that of the past month; this statement being applicable both to the Thames-derived and the Lea-derived supplies. The following table shows the smallness of the proportion of organic matter present in the Thames-derived supply taken for illustration, and the successive, but not important, decrease in its proportion during the past three months. With the coming on, however, of any considerable rainfall, a corresponding unimportant increase in the proportion may be anticipated. The maximum proportion of organic carbon met with in any one of the 536 samples examined during the past three months, or 0·188 part in 100,000 parts of the water, corresponds as nearly as may be to a little over 0·3 of a grain of organic matter per gallon:—

	Ratio of Brown to Blue Tint. Means.	Oxygen required for Oxidation. Means.	Organic Carbon per 100,000 Parts. Means.	Organic Carbon per 100,000 Parts. Maxima.
March	8·6 : 20	0·043	0·144	0·188
April	5·6 : 20	0·033	0·125	0·147
May	4·7 : 20	0·029	0·119	0·143

The Lighting of Johannesburg.—The Johannesburg Lighting Company have received cable advice that the lighting of some of the principal streets of the town by gas commenced on the 20th inst.

SEVILLE WATER-WORKS COMPANY, LIMITED.

The Ordinary General Meeting of this Company was held last Tuesday, at the London Offices, No. 86, Cannon Street, E.C.—Mr. D. EVANS in the chair.

The SECRETARY (Mr. C. Crew) having read the notice convening the meeting.

The CHAIRMAN, in moving the adoption of the report, said he believed the shareholders would find it a satisfactory one, in the sense that the increase in water receipts had been quite up to the expectation of the Directors, and even a little in excess. On the other hand, they had suffered severely by the loss on exchange; but the results of the year's working enabled them to recommend the payment of a dividend at the rate of 4 per cent. per annum, and to carry forward £2691 17s. 6d. Their Auditors (Messrs. Deloitte, Dever, Griffiths, and Co.) had made an examination of the accounts; and they found that during the past year the maintenance and repairs, including irrigation and fire service, had been at the rate of 6·32 per cent., as against 7·74 per cent. in 1891; pumping and engine charges, 7·63 per cent., as compared with 8·91 per cent.; and salaries and office expenses, 18·9 per cent., as against 17·08 per cent. The losses on exchange had so disturbed expectations that the anticipated 4 per cent. earnings had not been realized. The yearly working profit in sterling was £8062, or slightly above 3 per cent. on the share capital; but had the exchange remained as in the previous year, the profit would have been about 3¾ per cent. Having reminded the shareholders of the desirability of investing the amortization fund as soon as circumstances permitted, he proceeded to remark that the Directors had made inquiries of their Solicitors, and found they were permitted to invest in their own debentures; and therefore they proposed, to some extent at all events, that the sinking fund should in future be so invested. The conversion of the 6 per cent. debentures was a little more difficult than was expected, because many of the debenture holders took their money for other investments. With the exception of about £20,000 of debentures, however, which fell due at the end of the month, all the bonds were now placed at 5 per cent. The shareholders would observe that, in order to pay 4 per cent. dividend, the Directors had had to draw rather heavily on the unappropriated balance; but they hoped, with an increase in the water-rentals, that on the next occasion they would be enabled to pay 4 per cent. out of the profits of the year.

Mr. CROWLEY LAMBERT, M.P., seconded the motion, which was unanimously carried.

The retiring Directors and the Auditors were re-elected; and votes of thanks to the Chairman and Directors and the Manager (Mr. C. A. Friend) brought the proceedings of the ordinary meeting to a close.

An Extraordinary Meeting was then held for the purpose of giving the Directors authority to raise the sum of £10,000, in addition to the £120,000 already raised.

The CHAIRMAN, in moving a resolution to this effect, explained that the reason the Directors had applied to the shareholders for permission to raise a further £10,000 was that they owed to their contractors a balance of £6000. As, by law, they were not permitted to issue any shares when their shares were under par, and they could not raise any more debentures, because they were limited to £120,000—that was, they could not raise any more to rank *pari passu* with the £120,000—they proposed to raise £10,000 of what might be called "B" debentures; and they would then have some security to offer if it became necessary to borrow money.

Mr. LAMBERT seconded the motion, which was agreed to.

The proceedings then terminated.

Acquisition of the St. Petersburg Water-Works by the Municipality.—The Directors of the City of St. Petersburg New Water-Works Company, Limited, have received a communication from the Water Committee of the Municipality of St. Petersburg, informing the Board that the Douma has decided to purchase the Company's undertaking. The Directors understand that it is the intention of the Douma to take over the works as from Jan. 1, 1893. The Municipality have referred it to the Water Committee to settle with the Company the exact terms of the purchase. The calculations which have to be made will be governed mainly by the net revenue during the last year of working.

The Public Lighting Question at Exeter.—Last Wednesday an exhaustive report was presented to the Exeter City Council on the subject of street lighting. The Committee who had the matter in hand recommended that the offer of the Gas Company to reduce the price of gas for the public lamps to 2s. 9d. per 1000 cubic feet, to provide five large lamp-posts and lanterns, and to supply them with gas at 2s. 6d. upon a seven years' contract be accepted, provided the Company would agree to a clause being inserted in the agreement for its determination at the end of five years by either party on six months' previous notice. The Committee further recommended that one of the main streets be lighted by lamps consuming 12 feet of gas an hour, reducible to 6 feet after midnight. It was estimated that the additional cost of lighting High Street and Queen Street by electricity would be £392 per annum. In the discussion on the subject, Mr. Munro took exception to the Council binding themselves to any company for so long a period as five years. The Mayor expressed regret that it did not seem possible to light the main streets of the city with electricity at present; but the extra cost was so great that he did not think their finances would warrant them in going to the expense. He thought the Gas Company ought to make the contract terminable at three years, as well as at five, on six months' notice being given. From what he heard, he did not think the Company would be disposed to make the additional concession. They were indebted to the Electric Light Company in a sense for the improved terms they had obtained from the Directors of the Gas Company. Mr. Wreford moved that, unless the contract was made terminable at the end of three years as well as five years, it should not be signed. This was agreed to. It was also decided to give the Gas Company notice to terminate the present contract at Michaelmas next.

NOTES FROM SCOTLAND.

From Our Own Correspondent.

Saturday.

Although it is rather early to speak of it yet, there is a belief in Glasgow that the financial results of the Corporation Gas Department will not work out so well as the Gas Committee have been accustomed to find them. There is nothing very surprising in this; and, indeed, there is nothing unexpected. A year ago, when considering what the price of gas should be, it was a question whether it should not be raised; but it was resolved to go on for another year at 2s. 6d. per 1000 cubic feet. There was a net surplus on the year's working of £1150; but sundry payments fell to be made out of that sum, leaving only £694 to be carried forward, which compared very unfavourably with the £3245 carried forward in 1890. Last year more was paid for coal, and less was realized for residuals. The capital account of the department is also, apart from the acquisition of the Partick, Hillhead, and Maryhill Gas Company's undertaking, considerably higher; and taking everything into account, it is no matter for surprise that a deficit should be experienced in the year's working. The only course open to the Corporation is to increase the price of gas; and a proposal to that effect is likely to be made when the accounts come up for consideration in August. One cannot but feel regret that the first balance-sheet of the extended working should show a result on the wrong side. But the inevitable cannot be avoided; and the Gas and Electric Lighting Committee will have sufficient reason to show for what must be a greater disappointment to them than to the community. It is satisfactory to know that the consumption of gas still goes on increasing.

The Dunfermline Gas Company have completed their first year under their reconstructed form; and in connection with it, it is satisfactory to observe that Mr. Mackenzie, who is a veteran in the industry, still finds affairs prospering in his hands. The Directors' report stated that, notwithstanding they had been charged increased rates for coal and had realized lower rates for residuals, they had not hitherto required to raise the price of gas. There had been an increased consumption; and the results of the business for the year were in every way satisfactory. The profit and loss account showed a balance of £2741, which admitted of the payment of the ordinary dividend of 10 per cent. During the year, important extensions had been made to the purifying plant, from which the Directors anticipated considerable economy in manufacture, as well as improvement in the quality of the gas. Other extensions, rendered necessary by the increased demand for gas, are being carried out. The Chairman stated that the Company was registered as a limited liability undertaking as from November last; and that the issue of additional capital was readily taken up by the shareholders—the shares applied for considerably exceeding the number issued. So far as the cost of coal was concerned, the price of gas might have been maintained at 3s. 7d. per 1000 cubic feet; but with the fall in the price of residuals, it was necessary to raise it to 3s. 9d. The proposals of the Directors were agreed to. In its reconstructed form, the capital of the Company has been increased from £29,750 to £60,000 nominal; and the actual subscribed capital, from £25,462 to £36,375.

It is pointed out, in a Dundee newspaper this week, that whereas in 1870 the consumption of gas was 200,605,200 cubic feet, last year it was 505,592,600 cubic feet; and that, while in the former year, with the price at 5s. per 1000 cubic feet, the revenue of the Gas Commissioners from gas was £43,406, last year, with the price at 3s. 8d., the revenue was £89,952. These are certainly very encouraging figures.

The Gas Committee of the Aberdeen Corporation, having had before them the report of Mr. A. Smith, their Engineer, on the quality of the coal which has been tendered to them, have resolved that the gas to be supplied is to be of 24-candle power; and they have agreed to purchase 36,500 tons of coal, at a cost of £35,475, or an average of 19s. 6d. per ton. The contract price for the coal at present being supplied is 23s. 1d. per ton. The difference in price should mean a considerable surplus.

The Dundee Gas Commissioners and their friends, to the number of about 60, held their annual excursion last Saturday. The party travelled to Loch Awe, where they spent the day in driving down the Pass of Brander and sailing on the Loch. In the afternoon, dinner was served in the Loch Awe Hotel, which is so much frequented by tourists. Both the Members of Parliament for the city—Mr. John Leng and Mr. Edmund Robertson—graced the table with their presence, and took part in the complimentary speeches which were given. The outing was altogether a most enjoyable one.

It is difficult to conceive a situation in which a man has a better opportunity for showing his capacity than in the management of a gas-works. The statistics which are often collected by owners with a view to ascertaining the cost of materials, output, &c., in a number of other works, are usually, even after being tabulated at great cost of time and labour, quite bewildering in their variations. The reason is that the personal equation of the managers of the different works cannot be reduced to a percentage and placed in a table. A very gratifying instance of the value of a man who is worth his salt is found in the experience of the Cambuslang Gas Company, since, three years ago, they appointed Mr. J. Donaldson to be Manager of their works. The town is one of the pleasant suburbs of Glasgow. It is a mineral district, and is riddled underground with a network of coal-workings, which give constant trouble to the Gas Manager by subsidences of the surface, and consequent breakages of mains. Three years ago, the unaccounted-for gas amounted to 15 per cent; it has now been reduced to 8 per cent. The other results are equally satisfactory. Coal has risen in price since 1889 between 5o and 6o per cent.; yet the price of gas has been reduced from 4s. 4½d. to 3s. 11½d., and, what is more wonderful, the dividend has been increased from 5 per cent. to 7½ per cent. This reads almost like a paradox; but it was all explained as hard fact at the annual meeting of the Company last week. Dealing with the past year, it is found that the Company had an output of 17 million cubic feet; and the personal equation of the Manager is at once apparent when it is learned that the capital upon which this was realized is only £13,350. The price of coal was 1s. 3d. per ton higher than in the preceding year, yet the profits were £140

more. There was sufficient surplus to pay a dividend at the rate of 10 per cent.; but the shareholders contented themselves with 7½ per cent., and placed about £400 to the reserve fund. The yield of gas was 150 cubic feet more per ton than in the previous year, and 1800 cubic feet more than it was three years ago. That is one explanation of the prosperity of the Company. There are probably others; but whatever they may be, they all have their centre in good management. This was the view of the Directors and the shareholders, for, after a neat and complimentary speech by the Chairman, they voted to Mr. Donaldson a sum of twelve guineas, and that, too, after having last year raised his salary by £20 per annum. The Company are resolved to deal handsomely by their customers as well as their officials; and they adopted a proposal by the Manager to sell gas for cooking and heating at 2s. 11d. per 1000 cubic feet, or 1s. 0½d. less than the ordinary price. This is certainly reciprocity all round; and the result of so generous a policy, and of so much encouragement of merit, will be worth watching for at the end of the current year.

Mr. W. Key, the late Manager of the Tradeston Gas-Works of the Glasgow Corporation, has issued his prospectus on commencing business on his own account as a heating and ventilating engineer. The document is a very prettily got up one. Mr. Key's head-quarters are in Hope Street, Glasgow; but he has opened branch offices in London and Aberdeen. Appended to the prospectus are a number of highly-complimentary testimonials to the efficiency of Mr. Key's method of ventilating by propulsion, as introduced by him in the Victoria Infirmary, Glasgow, the Palace Hotel, Aberdeen, and numerous public schools, libraries, &c., in Glasgow, Aberdeen, Rochdale, and other places.

In the midst of the existing depression in the Scotch oil trade, arising from severe competition with the oil wells of Russia and America, Sir James King, ex-Lord Provost of Glasgow and a Director of Young's Paraffin Light and Mineral Oil Company, perceives an outlet for oil-products which gives him hope for the future. In his capacity of Chairman at the annual meeting of the Oil Company the other day, he said "there were two good outlets which appeared to be opening up for their products. Year by year the railway companies, both in this country and on the Continent, were using oil more largely for making gas for the supply of carriage lamps. Also, the price of cannel coal had latterly been ruling so high that gas managers were turning their attention to oil so as to increase the illuminating power of the gas obtained from lower priced coal." Sir James King has experience of one branch of what he was speaking about. He is a director of the Caledonian Railway Company, which use oil gas very largely for the lighting of their carriages. The popular notion is that oil and gas are deadly rivals; but these observations place them in another light, and show oil to be the handmaid of gas. But it has to be remembered that the speaker was addressing a meeting of shareholders in an Oil Company which was paying a diminished dividend. At the same time, his remarks have a meaning which he probably did not intend them to have; and that is that, if the enriching of gas with oil should become general, the price of the latter would rise so much that the value of the process, from a financial view, would be to a large extent taken away.

The accounts of the Dundee Water Commission for the past year, which were lately submitted, showed that the income had been £47,201, and that there was a surplus of £1883. The actual income for the year was £44,312; but there fell to be added to it a surplus of £2889 from the previous year. The total debt of the Commissioners is £508,233.

At a meeting on Monday of the Greenock Water Trust, the balance-sheet for the year which ended on May 26 last was submitted. It showed a revenue of £25,435 and an expenditure which left a surplus of £2 16s. 1d. The revenue from the various sources was as follows: Domestic rate, £5546; public rate, £2136; general rate, £1980; shipping rate, £1068; water power, £4098; public works, £10,037; water-meters, £442; and properties, £125. The Chairman (Mr. W. Smith) reported that the, preferable bonds of the Trust were now reduced to £11,110; and that, as the most extended period is Whitsunday, 1893, the whole will be extinguished by that time. The loans falling due for rearrangement at the past term have been well renewed. Of the sum of £68,384 falling due, only £9500 was called up.

Alleged Improper Use of Water.—In the Queen's Bench Division, a short time since, the case of *Evans v. Gornall* came before Justices Mathew and Wright, in the form of an appeal by way of special case from the decision of certain justices of Chorley, raising an important question as to whether the inhabitants were entitled to use their waste-water for water-closets or any other purpose. Mr. Moulton, Q.C., with whom was Mr. Forbes Lancaster, appeared in support of the appeal, and said that, although the sum involved in this particular case was small, the point raised was one of considerable importance. The contention of Mr. Gornall was that, having once used water for domestic purposes, he was entitled to employ it in any way he liked before allowing it to run into the sewers. He (the learned Counsel) submitted that the water was supplied expressly for domestic uses; and there was no right on the part of the customer to use it for any other purpose. If the use of the apparatus employed by Mr. Gornall became general, not only would the special charge for water for water-closets be avoided, but the water which was supplied without limit for domestic purposes would be so lavishly used that the difficulty of the supply would be much enhanced. Apart from mere waste, they objected to the action of Mr. Gornall on sanitary grounds. It was true that they were not the sanitary authority; but they objected to any connection between an apparatus of the kind used and their pipes. Their Lordships, without hearing Counsel for the respondent, dismissed the appeal with costs. Mr. Justice Mathew said, in his opinion, what was contemplated by the section was a misuse of the water. It could not, however, he said that the respondent had in any way misused the water. Mr. Justice Wright said he was of the same opinion. The sole object of the section was to prevent a person taking more water under the colour of domestic use than was reasonably wanted for that purpose. There was nothing of the sort in the present case.

CURRENT SALES OF GAS PRODUCTS.

LIVERPOOL, *June* 25.

Sulphate of Ammonia.—Some improvement is noticeable in the market; and Hull quotations are advanced to £9 17s. 6d. to £10, while the latter price has actually been paid f.o.b. Leith. In view of the very small quantity now on the market, and the possibility of a better demand, more particularly for the Colonies and America, during July, a hardening of prices seems inevitable, however much it may be opposed by such of the dealers who are committed to low summer prices. Considerable shipments are taking place at nearly all the ports, therefore arguments in favour of decline, because of the absence of demand, are futile and artificial in view of these facts. The supply of liquor from gas-works is falling alarmingly short; and there seems some difficulty in carrying out existing contracts. The large inquiry this week for forward contracts indicates that buyers show greater confidence in the future; but the low range of prices does not offer any inducement to producers to commit themselves ahead. Nitrate is getting dearer; 8s. 3d. being now quoted for good quality on spot.

LONDON, *June* 25.

Tar Products.—Producers of benzol have apparently ceased pressing sales. The low price of benzol is doubtless a good deal due to the demoralized feeling that took hold of the makers a few months' ago. They now see the folly of their action, as, notwithstanding the repeated statements of a large over-production, the fact remains that to-day there are practically no stocks anywhere. This product looks like seeing better days. The same, however, cannot be said of anthracene, carbolic acid, and creosote, all of which are weak and difficult to sell. Carbolic acid is moving off; but prices do not improve. Important tar contracts have been fixed at prices ranging between 8s. 6d. and 11s. Other business is reported at: Pitch, 28s. Benzol, 90's, 1s. 8d.; 50's, 1s. 4½d. Toluol, 1s. 2½d. Solvent naphtha, 1s. 3d. Crude benzol naphtha, 30 per cent., 8d. Creosote, 1d. Naphthalene salts, 20s.; pressed, 45s. Carbolic acid, crude, 60's, 1s. 1d.; 70's, 1s. 4d.; crystals, 5d. Cresol, 8d. Anthracene, 30 per cent., "A" quality, 10d.; "B" quality, 7d.

Sulphate of Ammonia.—A good feeling prevails in this market; and the price of sulphate is likely to improve. There are plenty of buyers at £9 12s. 6d. to £9 15s. 0d., less 3½ per cent.; while makers are asking 2s. 6d. to 5s. more. Gas liquor (10-oz.) is quoted at 5s. 6d. to 6s. 6d.

COAL TRADE REPORTS.

From Our Own Correspondents.

Lancashire Coal Trade.—Business continues very slow so far as all descriptions of round coal are concerned; and although many of the collieries are not working more than four days per week—whilst five days is now practically full time under the restriction to be enforced by the miners—stocks are accumulating at most of the collieries. It is only in exceptional cases where these are of any great weight, the limited "get" necessarily preventing large accumulations; and as a rule, stocks are of less weight than they were at this time last year. The best qualities of round coal are in very restricted request for house-fire consumption. But prices have been well maintained, as concessions would scarcely lead to any materially increased rate of buying; and it is more than doubtful whether any really material modification of pit prices will be made during the present summer. At the pit mouth best Wigan Arley still averages 12s., Pemberton four feet and second qualities of Arley, 10s. to 10s. 6d., and common house-fire coals, 8s. 6d. to 9s. per ton. With regard to the lower descriptions of round coal, for steam and forge purposes, however, there is a decided weakness in the market. This description of fuel is becoming increasingly difficult to dispose of, owing to the depressed condition of the principal coal-using industries; and although nominally there is no material giving way upon list rates, surplus lots are pushed for sale upon the market at low figures, and buyers prepared to take anything like quantities are enabled to secure these at considerably below the nominal list rates. At the pit mouth 7s. 6d. to 8s. per ton would now represent the full average price obtainable for ordinary descriptions of steam and forge coal. For shipment, prices continue very irregular; and although 9s. 3d. to 9s. 6d. is still being got in some instances for good qualities of steam coal, delivered at the ports on the Mersey, 8s. 9d. to 9s. represent more nearly the average selling prices for ordinary descriptions. In gas coals, contracts are being freely settled; but it is difficult to ascertain the price at which consumers are securing their supplies. The Manchester Corporation contracts are stated to have been renewed at something about last year's rates, any variation from these being slightly in favour of the buyers. Generally, however, from what can be ascertained, buyers are not enabled to get down prices to any material extent; and whilst 3d. per ton represents the full average concession upon last year's prices that is being made in connection with contracts settled for the ensuing season's supplies, any giving way beyond this is only in very exceptional cases. For engine classes of fuel, there is a generally brisk demand, with supplies of the better qualities, if anything, rather scarce in some instances; and prices show a hardening tendency. At the pit mouth good qualities of burgy average 6s. 3d. to 6s. 9d.; best qualities of slack, 5s. to 5s. 6d.; good ordinary descriptions, 4s. 3d. to 4s. 9d.; and common sorts, about 3s. 6d. per ton.

Northern Coal Trade.—Though local holidays have interfered with the production of coal, yet there is now a full output; and in some classes the limited consumption has caused a reduction of prices. Best Northumbrian steam coal is now quiet at about 10s. 3d. per ton, f.o.b.; whilst for forward delivery a lower price is taken. There is a further reduction in the price of small steam coal, which may now be had at 4s. to 4s. 6d. per ton, the output being large and the consumption rather irregular. For gas coal, with a production that is nearer the normal volume, the demand is very steady; and as many of the collieries have very heavy contracts, the price—though varying a little

according to the position of the colliery and the time of the delivery that is stipulated for—is on the whole well maintained. For prompt delivery, as high as 9s., less discount, is asked for best Durham gas coal, f.o.b.; and the price varies from that down to about 7s. 9d., according to quality and time of delivery. It would seem that the production of gas coal is being better taken up than had been anticipated; and that in consequence, the amount of the free coal is rather limited. Household coal is very dull; and the price is drooping. A similar remark applies to bunker coal, which is being sold very low in price—7s. 7d. f.o.b. having been taken for unscreened coal. Possibly, lower prices have to be accepted to induce a renewal of orders that had been diverted. Manufacturing coal is quiet. Coke for blast furnace purposes, is firm at about 17s. per ton f.o.b., with a large demand. Gas coke is quiet; the demand and the production being both low just at present.

Scotch Coal Trade.—Trade keeps fairly busy; dealers being, for the most part, well supplied with orders for a month or two. Ell coal is a little more plentiful than last week; but the demand continues about equal to the supply. Some of the smaller collieries are pressing their production on the market. The larger concerns are, however, inclined to hold out—in view, probably, of the early advent of winter orders. The men in the west are working steadily as yet; but their holidays are approaching, and for the next two weeks, at all events, while the General Election lasts, it is likely that the output will go down. In Fifeshire, they have been holidaying already; and as the coal masters are about to meet to consider the question of wages, it is possible that there may be more idling, and that a good deal of the trade which came north may return to Durham. The situation is therefore not altogether satisfactory—in fact, is rather mixed. Everything, however, points to quieter prices being the rule in the coming winter. It is reported that in the west there has already been an easing of prices to the extent of 3d. per ton all round; but this would seem to be going too far. The prices given this week are: Main, 7s. 6d. to 7s. 9d.; ell, 8s. 6d.; splint, 8s. to 8s. 6d.; and steam, 10s. to 10s. 3d. per ton. Shipments still go up. Last week the total quantity exported was 167,718 tons—an increase over the corresponding week of last year of 43,704 tons, and of 6347 tons over the preceding six days. For the year to date, the total shipments have been 3,281,328 tons—an increase over last year of 519,169 tons.

Stockholm Water Supply.—The Stockholm Water-Works had, up to the end of last year, entailed an expenditure of about £350,000. The total length of water-pipe laid was 157,571 metres. The net profits amounted to £22,000, representing rather more than 6 per cent. on the cost. During the year the consumption of water was about 1700 million gallons, of which quantity 1100 millions were used for domestic purposes.

Eastbourne Electric Lighting Company.—The report of the Directors of this Company, which was submitted at the meeting of shareholders yesterday week, is a very interesting one. It stated that for the past six years the installation had been under the management of Mr. Robert Hammond, who, with the aid of certain capitalists associated with him, had, under an agreement, found all the necessary plant for carrying on the undertaking. The result was that the plant had been renewed, and the lighting business had improved and extended, until the annual losses had entirely disappeared, and a considerable surplus beyond working expenses realized. Having satisfied themselves that the revenue had sufficiently improved, so as to provide a substantial surplus beyond working expenses, the Directors resumed direct charge of the undertaking at the beginning of the year. The late managers had agreed with the Directors that the debentures to them for the amount of their outlay and losses should stand for ten years, and that the interest should be reduced to 5 per cent. For the fifteen months to Dec. 31 last, the profit over working expenses was £1950; and the total amount of debenture issue, after completing arrangements with the managers, would be £21,550 at 5 per cent., and this with share capital issued of £10,550, would represent the total capital expenditure of the Company. The Directors also mentioned that they had decided to reduce the price of the current to the consumers from 10d. to 9d. per unit from the 30th inst., hoping that an increase of business would compensate the Company for the reduction. The report was adopted; and a sum of £250 was voted to the Directors as remuneration for the period from Dec. 30, 1890, to March 31 last.

Electric Lighting for Chester.—Dr. J. Hopkinson has prepared a report, for the Chester Town Council, on the supply of electricity for lighting purposes. He states that it is not probable the demand will be great in the borough in the near future; and he is of opinion that a low-tension system with a small battery of accumulators is much to be preferred to a high-tension system. As the distance of the site he suggests is not too great, he strongly advises the use of the low, direct-current three-wire system, with a small battery of accumulators. He understands that £15,000 has been sanctioned for the proposed works, exclusive of the land upon which they are to be erected; while his estimate for the plant required for a thoroughly satisfactory generating works is £16,224, exclusive of the cost of taking up the streets and making them good again. The length of mains provided for is nearly three miles. The plant will enable a supply at one and the same time of 3000 16-candle power lamps, and will certainly permit 4000 lamps to be connected to the circuits. The annual cost of working and maintaining the plant he estimates at £745, and maintenance at £1196. The average cost to consumers for the supply will be about 6d. per unit; and, taking light for light, this is equivalent to gas at 5s. per 1000 cubic feet. He understands that gas in Chester costs about two-thirds of this, and it will be a matter of very grave consideration for the Corporation whether they should endeavour to supply electricity at such a price that it will cost no more than gas. On the whole, although he does not regard Chester as a specially favourable town for the electric light, he can see no reason to doubt that an electric lighting central station would speedily pay its current expenditure, interest upon the capital employed, and something over for extinguishing by depreciation the cost of the plant. The report has been referred to the Watch Committee for consideration.

Braddock's Meters.—The Corporations of Oldham and Walsall have each accepted the tender of Messrs. J. and J. Braddock, of the first-named town, for the supply of wet gas-meters in cast-iron cases during the next twelve months.

Gas Exhibition at Keswick.—During the past week a very well-arranged display of Messrs. Richmond and Co.'s gas ranges and stoves was held under the auspices of the Keswick Gas Company. Cookery lectures were given by Miss Owen, of South Kensington. We may mention that Mr. Richmond has lately issued, in pamphlet form, incorporated with a catalogue of the firm's appliances, his popular lecture on "Gas as a Domestic Servant;" and it has been largely circulated in various parts of the country.

The Water Supply of Gildersome.—An action brought by the Attorney-General, at the relation of the Corporation of Bradford, against the Corporation of Morley and the Gildersome Local Board, came before Mr. Justice Chitty last Wednesday, in the Chancery Division of the High Court of Justice, on the motion for an injunction to restrain the Corporation of Morley from acting on an agreement to supply and sell water to the Gildersome Local Board. The Corporation of Bradford sought a declaration by the Court that an agreement entered into by the Corporation of Morley to supply water to the Gildersome Local Board was void because it had not had the sanction of the Local Government Board. The plaintiffs alleged also that since the commencement of the present year the Corporation of Morley had supplied the Gildersome Local Board beyond the limits defined in the agreement. As stated by Mr. Levett, Q.C., who appeared, with Mr. Eyre, for the Bradford Corporation, the case now was that since the action was brought, the Corporation of Morley had applied to the Local Government Board for the requisite sanction to the agreement; and the Board had determined to hold an inquiry, at which the Corporation of Bradford would be heard. Terms were come to between the parties by which proceedings were stayed pending the inquiry; and his Lordship granted a postponement.

GAS AND WATER COMPANIES' STOCK AND SHARE LIST.

(For Stock Market Intelligence, see ante, p. 1235.)

Issue.	Share	When ex-Dividend	Dividend or Div. Bonus.	NAME	Paid per Share	Closing Prices.	Rise or Fall in Wk.	Yield upon investment.
£			p. c.	GAS COMPANIES.				£ s. d.
590,000	10	13 Apr.	10½	Alliance & Dublin 10 p. c.	10	16½—17½	..	6 0 0
100,000	10	,,	7½	Do. 7 p. c	10	11—12	..	6 5 0
300,000	100	2 Jan.	5	Australian (Sydney) 5 % Deb.	100	105—107	..	4 13 5
100,000	20	27 May	8	Bahia, Limited	20	10—12	..	13 6 8
200,000	5	12 May	7½	Bombay, Limited	5	6¼—6¾	..	5 11 1
40,000	5	,,	7½	Do. New	4	4¼—5	..	6 0 0
380,000	Stck.	26 Feb.	12½	Brentford Consolidated	100	212—217	..	5 12 11
150,000	,,	,,	9½	Do. New	100	164—168	..	5 10 1
220,000	20	11 Mar.	11½	Brighton & Hove Original	20	40—42	..	5 9 6
888,500	Stck.	11 Mar.	5	Bristol	100	95—100	..	5 0 0
320,000	20	13 Apr.	11½	British	20	41—43	—1	5 4 8
50,000	10	26 Feb.	11½	Bromley, Ordinary 10 p. c.	10	19—20	..	5 15 0
51,510	10	,,	8½	Do. 7 p. c.	10	15—16	..	5 6 3
328,750	10	—	—	Buenos Ayres (New) Limited	10	6¾—7¼	..	—
200,000	100	2 Jan.	6	Do. 6 p. c. Deb.	100	94—97	..	6 3 9
150,000	20	26 Feb.	8	Cagliari, Limited	20	25—27	..	5 18 6
550,000	Stck.	13 Apr.	13	Commercial, Old Stock	100	229—234	..	5 11 1
165,000	,,	,,	10	Do. New do.	100	180—185	..	5 8 1
130,000	,,	15 June	4½	Do. 4½ p. c. Deb. do.	100	117–120*	..	3 15 0
800,000	Stck.	15 June	13	Continental Union, Limited	100	218–223*	..	5 16 7
200,000	,,	,,	10	Do. 7 p. c. Pref	100	185–195*	..	5 2 7
75,000	Stck.	30 Mar.	10	Crystal Palace District	100	185—195	..	5 2 7
486,090	10	29 Jan.	10	European, Limited	10	19—20	..	5 0 0
354,060	10	,,	10	Do. Partly paid	7½	14—15	..	5 0 0
5,470,820	Stck.	12 Feb.	12	Gaslight & Coke, A, Ordinary	100	207—212	..	5 13 2
100,000	,,	,,	4	Do. B, 4 p. c. max.	100	94—98	..	4 1 7
665,000	,,	,,	10	Do. C, D, & E, 10 p.c. Pf.	100	250—255	..	3 18 5
30,000	,,	,,	5	Do. F, 5 p. c. Prf.	100	118—123	..	4 1 3
60,000	,,	,,	7½	Do. G, 7½ p. c. do.	100	169—174	..	4 6 2
1,300,000	,,	,,	7	Do. H, 7 p. c. max	100	154—158	..	4 8 7
463,000	,,	,,	10	Do. J, 10 p. c. Prf.	100	247—252	..	3 19 5
476,000	,,	,,	—	Do. K, 6 p. c. Prf.	100	148—153	..	3 18 5
1,061,150	,,	15 June	4	Do. 4 p. c. Deb. Stk.	100	114–116*	..	3 9 0
294,850	,,	,,	4½	Do. 4½ p. c. do.	100	118–121*	..	3 14 4
908,000	,,	,,	6	Do. 6 p. c. do	100	163–166*	..	3 12 3
3,800,000	Stck.	12 May	12	Imperial Continental	100	210—214	..	5 12 1
75,000	5	15 June	6	Malta & Mediterranean, Ltd.	5	4—4½*	..	6 13 4
560,000	100	1 Apr.	5	Met. of Melbourne, 5p. c. Deb.	100	108—110	..	4 10 11
541,920	20	15 June	5	Monte Video, Limited	20	14—15*	..	6 13 4
150,000	5	27 May	10	Oriental, Limited	5	7½—8½	..	6 1 2
60,000	5	30 Mar.	7	Ottoman, Limited	5	4—5	..	7 0 0
166,870	10	26 Feb.	2	Pará Limited	10	2—3	..	—
420,000	100	3 May	6	People's Gas of Chicago— 1st Mtg. Bds.	100	106—110	..	5 9 1
500,000	100	1 June	6	2nd Do.	100	100–103	..	5 16 7
150,000	10	15 Oct.	10	San Paulo, Limited	10	8—9	..	—
500,000	Stck.	26 Feb.	15½	South Metropolitan, A Stock	100	265—270	..	5 14 10
1,350,000	,,	,,	12	Do. B do.	100	214—218	—1	5 10 1
200,000	,,	,,	13	Do. C do.	100	230—240	..½	5 8 4
725,000	,,	30 Dec.	5	Do. 5 p. c. Deb. Stk.	100	142—146	..	3 8 6
60,000	Stck.	11 Mar.	11½	Tottenham & Edm'nton, "A"	100	225—230	..	5 0 0
				WATER COMPANIES.				
743,952	Stck.	30 Dec.	10	Chelsea, Ordinary	100	253—258	..	3 17 6
1,720,252	Stck.	13 Apr.	8	East London, Ordinary	100	195—200	..	4 0 0
544,440	,,	30 Dec.	4½	Do. 4½ p. c. Deb. Stk.	100	138—142	..	3 3 4
700,000	50	11 Dec.	8½†	Grand Junction	50	101—105	+2	4 0 11
708,000	Stck.	12 Feb.	10½	Kent	100	260—265	..	3 19 3
1,043,800	100	30 Dec.	9½	Lambeth, 10 p. c. max.	100	227—232	+3½	4 1 10
406,200	100	,,	7½	Do. 7½ p. c. max.	100	194–199	+4	3 15 5
279,700	Stck.	30 Mar.	4	Do. 4 p. c. Deb. Stk.	100	122—125	+1	3 4 0
500,000	100	12 Feb.	12½	New River, New Shares	100	325—335	..	3 22 4
1,000,000	Stck.	29 Jan.	4	Do. 4 p. c. Deb. Stk	100	127—130	..	3 1 6
902,300	Stck.	15 June	6½	S'thwk & V'xhall, 10p. c. max.	100	147–152*	..	4 5 6
126,500	100	,,	6½	Do. D 7½ p. c. do.	100	134–138*	..	4 14 5
1,155,066	Stck.	15 June	10	West Middlesex	100	237–242*	..	4 2 8

*Ex div.

† Next dividend will be at this rate.

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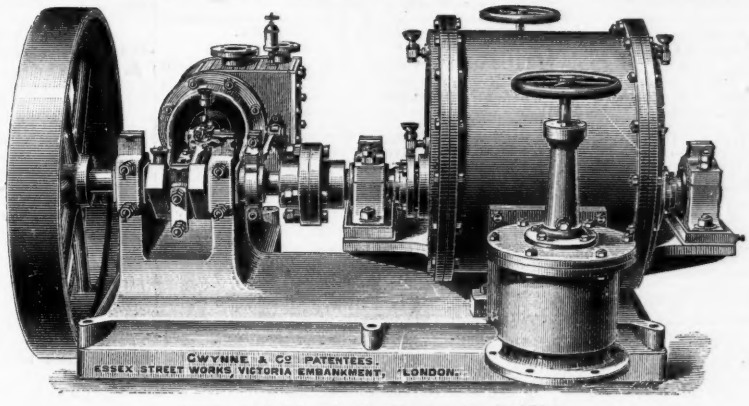

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JOHN WM. O'NEILL, Managing Director.

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*** See Advertisement p. 1261 of this week's issue.

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Engineer and Manager.

Water-Works Office, Devonport,
June 20, 1892.

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ON SALE, in good condition—Eight 12-inch flanged SLIDE-VALVES. May be seen at the Gas-Works, Guildford.

Further information on application to Mr. Lloyd, Gas Manager.

By order,
WILLIAM LONGWORTH,
Secretary.

Gas Offices, Guildford,
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Offers to be forwarded to the undersigned.

HANBURY THOMAS,
General Manager.

Gas Offices, Sheffield,
June 22, 1892.

BRIERLEY HILL DISTRICT GASLIGHT COMPANY.

THE Directors of this Company invite TENDERS for the supply of 5000 to 6000 tons of GAS COAL (2240 lbs. to the ton) for the year ending June 30, 1893, to be delivered in quantities as required to Brettell Lane Station and Round Oak Siding, G.W.R.

No Tender Forms are issued.

Tenders to be sent in, endorsed "Tender for Coal," not later than July 16 next.

The Directors do not bind themselves to accept the lowest or any tender.

HENRY M. JACKSON,
Secretary.

Board-Room, Gas-Works,
Brierley Hill, June 20, 1892.

BRIERLEY HILL DISTRICT GASLIGHT COMPANY.

THE Directors of the above Company are prepared to receive TENDERS for the surplus TAR, for One year ending June 30, 1893, made at their Brierley Hill and Kingswinford Works, delivered into boats at the former place in One hour, and the latter place in Twelve hours.

Tenders to be sent in, endorsed "Tender for Tar," not later than July 16 next.

The Directors do not bind themselves to accept the highest or any tender.

HENRY M. JACKSON,
Secretary.

Board-Room, Gas-Works,
Brierley Hill, June 20, 1892.

TENDERS FOR GAS COAL.

THE Directors of the Colwyn Bay and District Gas and Lighting Company, Limited, are prepared to receive TENDERS for from 800 to 1000 tons of GAS COAL, to be delivered at Colwyn Bay Station.

Particulars on application to the SECRETARY, Gas Office, COLWYN BAY.

CORPORATION OF MOSSLEY.
(GAS DEPARTMENT.)

THE Gas Committee are prepared to receive TENDERS for the supply of 7000 tons of COAL and 1000 tons of CANNEL.

Sealed tenders to be sent to the Town Clerk, endorsed "Gas Coal," not later than Noon on the 11th of July.

Particulars and Form of Tender may be obtained on application to the Manager (Mr. Richard Merrell).

The Committee do not bind themselves to accept the lowest or any tender.

By order,
JOSEPH HYDE,
Town Clerk.

Mossley, June 11, 1892.

COUNTY BOROUGH OF SALFORD.
(GAS DEPARTMENT.)

TENDERS FOR GENERAL STORES.

THE Gas Committee of the Corporation are prepared to receive TENDERS for the following MATERIALS, in such quantities as may be required during the Twelve months following the acceptance of Tenders, viz.—

1. Iron.
2. Tin Sheets, &c.
3. Lead and Composition Pipes, Glass, Pig Lead, &c.
4. Bolts, Nuts, Rivets, &c.
5. Iron Castings.
6. Brass Meter Taps and Keys.
7. Steam Tubing and Fittings.
8. Gas-Meters.
9. Paints, &c.
10. Chandlery.
11. Oils, &c.
12. Cotton Waste.
13. India-rubber Sheetings, Rings, &c.
14. Portland and Roman Cement.
15. Timber.
16. Rope and Yarn.
17. Haulage.
18. Horse Provender.
19. Veterinary Attendance.
20. Brushes and Besoms.
21. Steel Shovels.
22. Lime.

Forms of Tender and all further Information may be obtained on application to the Engineer, Gas Offices, Bloom Street, Salford.

Sealed tenders, endorsed "Tender for Miscellaneous Goods," together with samples of goods offered, addressed to the Chairman of the Gas Committee, Town Hall, Salford, must be delivered to me not later than Five p.m., on Thursday, the 7th of July next.

By order,
SAML. BROWN, Town Clerk.

Town Hall, Salford,
June 16, 1892.

PONTYPOOL GAS AND WATER COMPANY.

CONSTRUCTION OF NEW WORKS, ETC.

AUTHORIZED CAPITAL	**£100,000**
ISSUED AND FULLY PAID-UP CAPITAL—	
A Shares and Stock	**£26,400**
B Shares	**10,000**
4 per cent. Debentures	**7,500**
	£43,900

Issue of 1500 New "C" Shares of £10 each, to rank equally with the Ordinary "B" Shares of the Company, and *pari passu* (according to the respective Maximum Dividends) with the Ordinary "A" Shares and Stock—payable £1 per Share on application, and the balance on the 31st of August, 1892.

DIRECTORS.

CHARLES JAMES PARKES, Esq., J.P., Wentsland, Pontypool (*Chairman*).
EDWIN GROVE, Esq., J.P., Newport, Mon., Chairman Monmouthshire County Council (*Vice-Chairman*).
ALFRED ADDAMS WILLIAMS, Esq., J.P., Maesderwen, near Pontypool.
FREDERICK PHILLIPS, Esq., Green Lawn, near Pontypool.
THOMAS HEDGES DEAKIN, Esq., Parkend, Gloucestershire.
WILLIAM HENRY DAVIES, Esq., Glansychan, near Pontypool.

MANAGER.

LIEUT.-COL. ANDREW HAIR, Trosnant House, Pontypool.

SECRETARY and OFFICES.

T. B. PEARSON, Trosnant, Pontypool.

TENDERS are invited for the purchase of the above in Lots of 10 Shares; but Applicants may Tender for any number of Lots.

The Shares are sold pursuant to the powers conferred on the Company by and subject to the provisions of the Pontypool Gas and Water Act, 1890, and the Acts incorporated therewith; and all Tenders will be deemed to be subject thereto, and to the terms herein contained.

The Maximum Dividend on the "A" Stock and shares is 10 per cent., and on the "B" (and "C" Shares now created) 7 per cent.; and, in case of any insufficiency in the net revenue to yield such percentages, a proportionate reduction will be made in the Dividend on each class of Shares.

The Company have paid 7½ per cent., free of Income-Tax, on the "A" Shares since 1874, and 5 per cent., free of Income-Tax, on the "B" Shares since the same were created in 1876.

The Shares will rank for Dividend as from the 1st day of September, 1892, provided the full purchase-money is paid as herein required.

Should no allotment be made, the deposit will be returned in full.

Forms of Tender may be obtained on application to the undersigned.

Sealed tenders, endorsed "Tender for Shares," to be sent to me not later than Friday, the 8th day of July, 1892.

By order,
T. B. PEARSON,
Secretary.

Trosnant, Pontypool,
June 7, 1892.

CHIPPING NORTON GAS COMPANY, LIMITED.

TENDERS are invited for the supply and delivery at Chipping Norton of from 250 tons to 900 tons of good screened GAS COAL or NUTS, in such quantities and at such times as the undersigned may direct.

Tenders to be addressed to THOS. BURTONSHAW, Manager.

TENDERS FOR COAL.

THE Directors of the Town of Dudley Gaslight Company are prepared to receive TENDERS for the supply of 12,000 tons of GAS COAL, to be delivered at the London and North-Western Railway or Great Western Railway Sidings, Dudley, in such quantities as may be required from the 1st of July, 1892, to the 30th of June, 1893.

Sealed tenders, addressed to the Chairman, and endorsed "Tender for Coal," to be sent in not later than the 5th of July.

The Directors do not bind themselves to accept the lowest or any tender, and reserve to themselves the right to divide the contract between two or more firms.

By order,
T. E. STILLARD,
Secretary.

Gas-Works, Dudley,
June 23, 1892.

RAMSGATE CORPORATION.
(GAS AND WATER DEPARTMENT.)

THE Gas and Water Committee invite TENDERS for about 207 feet of STOURBRIDGE or WORTLEY CLAY RETORTS, 22 in. by 16 in.; also 48,000 FIRE-BRICKS, various sizes and shapes, and 20 tons of CLAY.

Tenders to be sent in on or before Noon on Monday, July 4, 1892, addressed to the Chairman of the Gas and Water Accounts Committee, Hardres Street, Ramsgate, endorsed "Tender for Fire-Clay Goods."

Specification and full particulars on application to

WILLIAM A. VALON,
Engineer.

RAMSGATE CORPORATION.
(GAS AND WATER DEPARTMENT.)

THE Gas and Water Committee invite TENDERS for the supply of about 100 tons of best BRIMSTONE ACID (what is known as 80 per cent. Acid, with a Specific Gravity of 142° Twaddel), to be delivered in equal monthly quantities between the 1st of July next and the 1st of July, 1893.

Tenders to be sent in, addressed to the Chairman of the Gas and Water Accounts Committee, on or before Noon on Monday, July 4, 1892, endorsed "Tender for Sulphuric Acid."

The Committee do not bind themselves to accept the lowest or any tender.

Full particulars on application to

WILLIAM A. VALON,
Engineer.

COUNTY BOROUGH OF SALFORD.
(GAS DEPARTMENT.)

THE Gas Committee invite Tenders for the ALTERATION of a CONDENSER at their Liverpool Street Works.

Full particulars may be obtained of the Gas Engineer, Gas Offices, Bloom Street, Salford.

Sealed tenders, endorsed "Tender for Alteration of Condenser," addressed to the Chairman of the Gas Committee, to be delivered at my Office, before Five p.m., on Thursday, July 7 next.

By order,
SAML. BROWN,
Town Clerk.

Town Hall, Salford,
June 20, 1892.

COUNTY BOROUGH OF SALFORD.
(GAS DEPARTMENT.)

TAR.

THE Gas Committee invite Tenders for the purchase and removal of the Surplus TAR to be produced at their Bloom Street, Regent Road, and Liverpool Street Works, in Twelve months from July 18 next.

The approximate quantity will be 6000 tons.

Forms of Tender and Conditions of Contract may be obtained on application to the Gas Engineer, Gas Offices, Bloom Street, Salford.

Sealed tenders, endorsed "Tender for Tar," addressed to the Chairman of the Gas Committee, must be delivered to me on or before Thursday, the 7th of July, at Five o'clock in the evening.

By order,
SAML. BROWN,
Town Clerk.

Town Hall, Salford,
June 20, 1892.

TENDERS FOR GAS COAL.

THE Gas Committee of the Newry Town Commissioners invite TENDERS for the supply of from 3000 to 3600 tons of GAS COAL, to be delivered in such quantities as may be required by the Committee, and delivered free *ex* Ship or Steamer at Albert Basin, Newry.

The Coal to be fresh wrought, dry, and free from Clench, Pyrites, or other objectionable matter for Gas Making.

The Committee would assist the Contractor by allowing him to deliver about 1,000 tons of Coal prior to the middle of October next.

Further particulars may be obtained from Mr. A. Gibb, Manager.

Sealed tenders, endorsed "Tender for Coal," specifying the description and quality of the Coal and where raised, to be addressed to the Chairman, Gas Office, Kilmorey Street, Newry, and delivered not later than Thursday evening, the 7th of July next.

The Committee reserve to themselves the right to accept the whole or any portion of any quantity offered, and do not bind themselves to accept the lowest or any tender.

By order,
JOHN KERNAGHAN, Secretary.

Gas Offices, Newry,
June 24, 1892.

MESSRS. DEBENHAM, TEWSON, FARMER, and BRIDGEWATER'S MONTHLY LIST of Shops, Show-Rooms, Factories, and Waterside Premises, suitable for the Exhibition and Manufacture of Engineering and other Appliances, may be obtained, free of charge, at their Offices, 80, CHEAPSIDE, E.C.

BOLTON CORPORATION.
(GAS DEPARTMENT.)

THE Gas and Lighting Committee are prepared to receive TENDERS for the supply of best screened GAS COAL, COBBLES, and NUTS, and screened CANNEL, to be delivered between the 15th of August, 1892, and the 30th of June, 1893.

Tenders, addressed to Mr. Alderman Miles, Chairman of the Gas and Lighting Committee, Gas Offices, Bolton, and endorsed "Tender for Gas Coal, &c.," to be delivered on or before the 13th of July, 1892.

Specification, with quantities, Form of Tender, and further information, may be obtained from Mr. W. Walch, Gas Offices, Bolton.

R. G. HINNELL,
Town Clerk.

Town Hall, Bolton,
June 22, 1892.

CITY OF CARLISLE.

TAR CONTRACT.

THE Carlisle Gas Committee are pre- pared to receive TENDERS for the Surplus TAR to be produced at their Works, for a period of One or more years from the 30th of June next.

Any further particulars required can be obtained upon application to the Engineer, to whom sealed tenders, endorsed "Tender for Tar," must be delivered on or before July 5, 1892.

The Committee do not bind themselves to accept the highest or any tender.

J. HEPWORTH,
Engineer.

Gas-Works, Carlisle,
June 8, 1892.

CITY OF CARLISLE.

TENDERS FOR COAL AND CANNEL.

THE Carlisle Gas Committee are pre- pared to receive TENDERS for the supply of about 16,000 tons of screened or unscreened GAS COAL, and about 4000 tons of CANNEL, to be delivered at their Works in Carlisle in such quantities as may be directed, from July, 1892, to June, 1893.

Tenders, specifying the description of the Coal or Cannel, the pits at which they are raised, and the terms for the net monthly payment, are to be sent on or before July 5, 1892, endorsed "Tender for Coal."

J. HEPWORTH,
Engineer and Manager.

Gas-Works, Carlisle,
June 8, 1892.

CRAYS GAS COMPANY.

SUPPLY OF COAL.

THE Directors of the above Company are prepared to receive TENDERS for the supply of about 5000 tons of GAS COAL, to be delivered free at St. Mary Cray Station (L. C. & D. R.) between the 1st of July, 1892, and the 30th of June, 1893, in such quantities as shall from time to time be directed.

The Company can only cart between 20 and 30 tons per day.

The Directors do not bind themselves to accept the lowest or any tender.

Tenders, stating price, to be addressed to the undersigned, so as to arrive not later than Tuesday, the 5th of July, 1892.

W. B. MIMMACK,
Secretary.

Offices: The Gas-Works,
St. Mary Cray, Kent.

STRATFORD-UPON-AVON CORPORATION.
(GAS DEPARTMENT.)

TENDERS FOR GAS COAL.

THE Gas Committee invite Tenders for the supply of GAS COAL or NUTS of best quality, as may be required during the Twelve Months ending June 30, 1893; the whole of the quantity required being about 3500 tons, the same to be delivered free upon their Siding of the Great Western Railway Company.

The Committee do not bind themselves to accept the lowest or any tender.

Forms of Tender and any further information may be obtained of

J. S. CRANMER,
Secretary and Manager.

Corporation Gas-Works,
Stratford-upon-Avon, June, 1892.

COUNTY BOROUGH OF BRADFORD.

TO COLLIERY PROPRIETORS.

THE Gas and Electricity Supply Com- mittee of the Bradford Corporation are prepared to receive TENDERS for the supply of best GAS COAL, COBBLES, NUTS, and CANNEL, all to be well screened, dressed, and free from Shale and Pyrites, to be delivered at the several Works of the Corporation in the Borough, during the period of One year commencing on the 1st day of August next, in such quantities, weekly, as may be agreed upon.

Form of Tender, with any further information required, may be had on application to Mr. Wood, Gas Engineer, Town Hall.

Sealed tenders, endorsed "Tender for Coal," to be delivered to me on or before Thursday, the 14th of July next.

An assurance must be given by each Contractor that he pays to the workmen employed by him not less than the minimum standard rate of wages.

The Committee do not bind themselves to accept the lowest or any tender.

By order,
W. T. M'GOWEN,
Town Clerk.

Town Hall, Bradford,
June 24, 1892.

SULPHURIC ACID.

THE Gas Committee of the Keighley Cor- poration invite TENDERS for the supply of B.O.V. for making Sulphate of Ammonia.

Particulars and Form of Tender can be obtained on application to the undersigned, to whom tenders must be sent, sealed and endorsed "Tender for Acid," not later than Monday, the 4th day of July next.

By order,
JOHN LAYCOCK,
Engineer and Manager.

Gas Offices, Keighley,
June 21, 1892.

THE Directors of the Wakefield Gas- light Company are prepared to receive TENDERS for the supply of 25,000 tons of GAS COAL and NUTS during the ensuing Twelve months.

Also a separate TENDER for the supply and prompt delivery of 1000 tons of GAS COAL and NUTS additional, for Stock.

Forms of Tender may be obtained on application, and must be sent in, properly endorsed, not later than the 2nd of July next.

By order of the Board,
JNO. W. WHITAKER,
Manager.

Gas Office, Wakefield,
June 20, 1892.

TO GASHOLDER MAKERS.

THE Altrincham Gas Company invite TENDERS for the construction and erection of a GASHOLDER.

The Drawings and Specification may be seen at the Gas Offices, Altrincham, on application to the Manager, Mr. J. E. Lamb, and at the Office of Mr. Thomas Newbigging, C.E., 5, Norfolk Street, Manchester.

Copies of the Bill of Quantities and Form of Tender may be obtained from the latter on deposit of two guineas, which will be returned on receipt of a *bond fide* tender.

Sealed tenders, endorsed "Gasholder, Contract No. 2," to be addressed to me, and sent so as to reach me not later than Twelve o'clock Noon on Tuesday, the 12th day of July next.

The Directors do not bind themselves to accept the lowest or any tender.

F. R. B. LINDSELL,
Secretary.

Gas Offices, Altrincham,
June 16, 1892.

COUNTY BOROUGH OF WEST BROMWICH.
(GAS DEPARTMENT.)

TO COLLIERY PROPRIETORS.

THE Gas Committee are prepared to receive TENDERS for the supply of 22,000 tons of best screened GAS COAL, for use at their Works, Albion, West Bromwich.

The Coal will be required to be delivered in equal monthly quantities.

Also from 200 to 300 tons of SCOTCH or other high-class CANNEL COAL.

The Committee do not bind themselves to accept the lowest or any tender; and they reserve to themselves the right to divide the contract between several firms.

Forms of Tender may be obtained upon application to Mr. W. Littlewood, Manager of the Works.

Contractors are required to pay their workmen not less than the minimum standard rate of wages current in the district in which their Collieries are situated.

Sealed tenders, properly endorsed, to be addressed to me not later than Thursday, July 7.

By order,
THOS. HUDSON,
Secretary.

Town Hall, West Bromwich,
June 22, 1892.

COUNTY BOROUGH OF HALIFAX.

THE Gas-Works Committee of the Halifax Corporation are prepared to receive TENDERS (from Colliery Proprietors only) for the supply of 50,000 tons of GAS COAL and 10,000 tons of CANNEL COAL, to be supplied in such quantities as may from time to time be determined by the Gas-Works Committee during the year ending the 30th day of June, 1893.

Forms of Tender and further Information may be obtained on application to Mr. Thomas Holgate, Manager, Gas-Works, Halifax.

Tenders, endorsed "Tender for Coal," must be sent to me on or before the 7th of July, 1892.

The tender of any person paying less than the minimum standard rate of wages, and who does not observe the hours and conditions of labour generally recognized in the district, will not be accepted. This condition shall be construed to the acts of Sub-Contractors, where such may exist.

The Committee do not bind themselves to accept the lowest or any tender.

By order,
KEIGHLEY WALTON,
Town Clerk.

SEVENOAKS GAS COMPANY.

TO COLLIERY PROPRIETORS AND AGENTS.

THE Directors of the Sevenoaks Gas Company are desirous of receiving TENDERS for the supply of 5000 tons of GAS COAL, to be delivered during Nine months from July, 1892, to April, 1893, at the Bat and Ball Station (L.C. & D.R.), Sevenoaks.

The districts preferred are Durham, Newcastle, and Yorkshire; and two-thirds of the total quantity will have to be delivered by Jan. 31, 1893, and the remainder by the beginning of April, 1893.

The Directors reserve to themselves the right of dividing the Contract among two or more firms, and are not bound to accept the lowest or any tender.

Forms of Tender may be obtained on application to the Secretary; and the tenders must reach the Company's Office not later than Tuesday, the 12th day of July next, endorsed "Tender for Gas Coal," and addressed to the Chairman, William Hughes, Esq., 88, High Street, Sevenoaks.

By order,
HENRY HOW, Secretary.

Gas Office, Sevenoaks,
June 25, 1892.

GAS COAL.

THE Directors of the Gomersal Gas Com- pany invite TENDERS for the supply of about 1600 tons of screened or unscreened GAS COAL, delivered during the ensuing Twelve months at their Works, Gomersal, Birkenshaw Station, G.N.R., or Birstal, L. & N.W.R.

Tenders, endorsed "Tender for Coal," to be sent in to the undersigned not later than Twelve noon, on Monday, the 4th prox.

By order,
JOSEPH W. PITTS
Manager and Secretary.

Gas-Works, Gomersal
June 22, 1892.

LONGWOOD GAS COMPANY.

TENDERS FOR COAL.

THE Directors of the above Company invite TENDERS for the supply of from 3000 to 4000 tons of best GAS COAL, delivered at Longwood Station, in such quantities as may be required.

Tenders, stating price per ton, screened and unscreened, and endorsed "Coal," to be sent in, addressed to the Chairman, not later than the 16th day of July next.

JOHN LOWE MITTON,
Manager and Secretary.

Gas-Works, Longwood, Huddersfield,
June 23, 1892.

OSWALDTWISTLE LOCAL BOARD.

THE Gas Committee invite Tenders for the TAR and LIQUOR produced at their Works for One year from the 31st day of July, 1892.

The quantity of Coal carbonized is over 3500 tons.

Further particulars may be obtained from the Manager, Gas-Works, Church, near Accrington.

Endorsed tenders to be addressed to me and to be delivered not later than Wednesday, the 13th of July.

WM. SANDEMAN,
Clerk.

Local Board Offices, Oswaldtwistle,
June 17, 1892.

GAS COAL.

TENDERS are invited for the supply of from 2000 to 6000 tons of good GAS COALS, capable of yielding, under average working, 10,500 cubic feet of 15-candle Gas per ton of 20 cwt., and Coke of good quality.

Deliveries to be made in such quantities as may be required during Twelve months from July next.

Quotations to specify if coal is screened or unscreened.

Offers may be sent to me, endorsed "Tender for Gas Coal," during the next Ten days.

FRED. G. DEXTER.
Manager.

Water and Gas Company, Winchester,
June 14, 1892.

TENDERS FOR GASHOLDER.

THE Directors of the Rochester, Chat- ham, and Strood Gaslight Company invite TENDERS for the Construction and Erection of a TELESCOPIC GASHOLDER, with a Wrought-Iron GUIDE-FRAMING.

Plans can be seen, and Copies of Specification had, after the 27th of June, on application at the Offices of the Company, 58, High Street, Rochester.

Tenders, marked "Tender for Gasholder," to be delivered at the Offices as above before Noon of Thursday, the 28th of July, 1892.

The Directors will not be bound to accept the lowest or any tender.

WILLIAM SYMS, Secretary.

June 16, 1892.

BRIDGNORTH CORPORATION GAS-WORKS.

TO COLLIERY PROPRIETORS AND OTHERS.

THE Gas Committee hereby invite sealed TENDERS for the supply of GAS COAL, including Carriage to the Bridgnorth Railway Station, as follows:—

(1) For One, Two, or Three years, determinable at the option of the Gas Committee at the end of the first or second year.

(2) For One year only.

Evidence as to the quality of the Coal must accompany each tender.

Quantity required, about 1600 tons per annum, in proportionate deliveries as directed.

The contract to commence at the end of August.

Sealed and marked tenders must be sent to the undersigned not later than Saturday, the 9th of July.

The Committee do not bind themselves to accept the lowest or any tender.

J. H. COOKSEY, Town Clerk,
Secretary.

Bridgnorth,
June 23, 1892.

GLOUCESTER GASLIGHT COMPANY.

TENDERS FOR GAS COAL.

THE Directors of the above Company invite TENDERS for the supply of 20,000 tons of GAS COAL for One year, from the 1st day of August next, in such monthly quantities as may be required by the Company.

Tenders to state the price delivered at the Midland Railway Wharf, High Orchard, or the Great Western Railway Wharf, Llanthony, Gloucester; or, if sent (as preferred) by Water, the price delivered both in Vessel and at the Gas Company's Wharf, on the Gloucester and Berkeley Canal.

Sealed tenders, endorsed "Tender for Coal," specifying the description and quality of the Coal, to be addressed to the Chairman, Gas Offices, Eastgate Street, Gloucester, and delivered not later than Monday, the 11th day of July next.

The Directors reserve to themselves the right to accept the whole or any portion of any quantity offered, and do not bind themselves to accept the lowest or any tender.

By order,
WILLIAM E. VINSON,
Secretary.

Gas Offices, Gloucester,
June 9, 1892.

THE NEW GAS GLOBE (Shadowless), Furness Patent. Must supersede all others. Sample on view at 177, High Street, Hounslow, Middlesex, where offers will be received to work the patent on royalty or otherwise, or to purchase the patent outright.

TO IRONFOUNDERS, ETC.

THE Directors of the Sheffield United Gaslight Company invite TENDERS for the supply of RETORT-FITTINGS, including Hydraulic Mains, Ascension-Pipes, Buckstaves, &c., for 96 Mouthpieces at their Effingham Street Station.

Form of Tender, with Bill of Quantities, may be obtained, and Drawings can be seen, on application to the Engineer, Mr. Fletcher W. Stevenson, on and after Saturday, the 18th inst.; and sealed tenders must be delivered, addressed to the undersigned, not later than Saturday, July 2, endorsed "Tender for Retort-Fittings."

The Directors do not bind themselves to accept the lowest or any tender.

HANBURY THOMAS,
General Manager.

June 11, 1892.

THE GASLIGHT AND COKE COMPANY.

NOTICE is hereby given, that the TRANSFER BOOKS of this Company, so far as they relate to the Company's Capital Stocks, WILL BE CLOSED on the Evening of Tuesday, the 5th day of July next, and be RE-OPENED immediately after the Half-Yearly Meeting of the Company, to be held in the month of August next.

By order,
JOHN ORWELL PHILLIPS,
Secretary and General Manager.

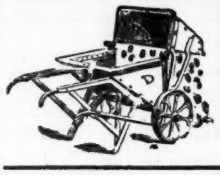
Chief Office: Horseferry Road,
Westminster, S.W., June 25, 1892.

HEALTH EXHIBITION, New Drill Hall, Portsmouth, including Sanitary Apparatus and Appliances, Arrangements for Water Supply, Heating and Cooking Apparatus, Electric Lighting, Smoke-Preventing Appliances, Articles relating to Personal Hygiene, Domestic Economy, Foods, Clothing, Life and Labour Saving Appliances, &c., to be held from Sept. 12 to Oct. 8, 1892, in connection with the Autumn Congress of the Sanitary Institute.

Prize Medals and Certificates of Merit will be awarded for approved exhibits.

Forms of Application for Space and all Particulars can be obtained from the CURATOR, Mr. W. H. Knight, 74A, Margaret Street, LONDON, W.

PRICE'S PATENT COKE & COAL BARROW



effecting a great saving of time labour, and expense.

For particulars, price, &c., apply to Mr E. PRICE, Inventor and Patentee, 22, Alwyne Road Canonbury, LONDON, N.

Prices are Reduced.

To effect a great saving in

GAS-FURNACES use our Special Derbyshire **GANNISTER BRICKS.**

ADDRESS

JAMES WHITE & Co., Limited,

ALBERT WORKS, WIDNES.

THOMAS ILLINGWORTH,

NORTH DEAN CHEMICAL WORKS,
Near HALIFAX,

MANUFACTURER OF SULPHURIC ACID

OF EXTRA QUALITY FOR MAKING

WHITE SULPHATE OF AMMONIA.

TAR, LIQUOR, AND SPENT OXIDE Purchased for Cash against Delivery.

COKE BREAKERS.

G. R. Mather & Son, Engineers, Wellingboro'.

IMPORTANT TO ENGINEERS AND GAS COMPANIES.

A NEW CARBURETTOR FOR ENRICHING GAS IN BULK.

The Carburettors have been doing practical work for the past two years; in many cases doing all the enrichment without the use of Cannel or other rich Coals. The South Metropolitan Gas Company have these Enrichers at all their Stations. The Gaslight and Coke Company have had them in use at some of their principal Works for two years past; and several more are now being fixed at their other Stations. The Carburettors are also in use at several Suburban and Provincial Gas Companies' Works.

FOR PRICES AND FULL PARTICULARS, APPLY TO

THE GAS LIGHTING IMPROVEMENT COMPANY, LIMITED,

(FRANK W. CLARK, Engineer and Manager)

18, DEVONSHIRE STREET, BISHOPSGATE, LONDON.

THE SPECIALITIES OF THE NEW CONVEYOR COMPANY, LTD.

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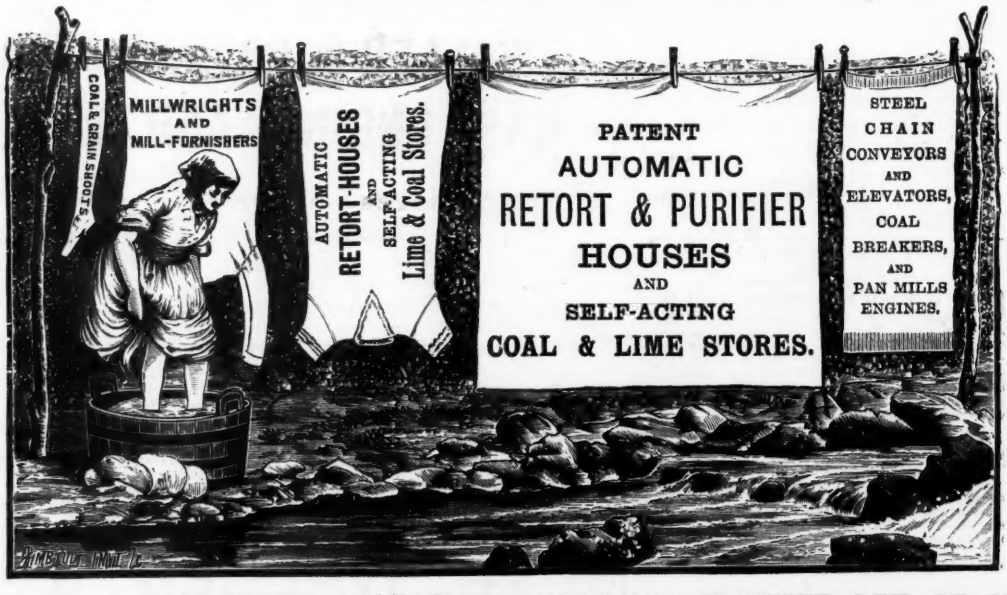
'LABORLESS.'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REGENERATIVE FURNACES.
Unsurpassed in
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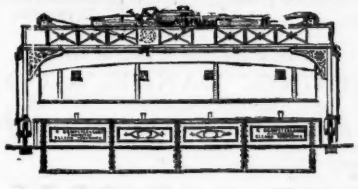
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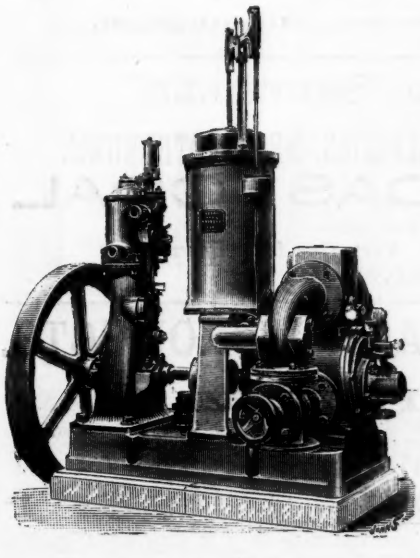
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OF SUPERIOR QUALITY
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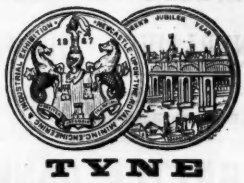

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Yield of Gas per ton	13,155 cub. ft.
Illuminating Power	38·22 candles.
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This Meter has a simple Automatic arrangement fitted, whereby, upon the insertion of a shilling, a supply of gas can be obtained, and which is cut off on the quantity paid for being consumed. The Meter gives warning when the quantity is nearly exhausted, so that another shilling may be inserted. There is, however, no occasion to wait until this happens, as a second shilling can be inserted after two-pennyworth of the first shilling has been consumed.

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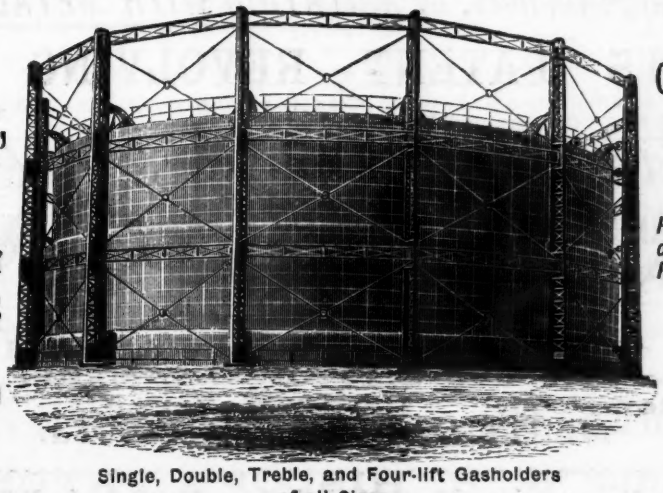

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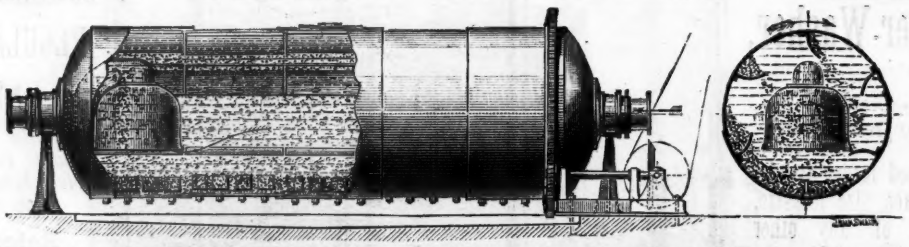

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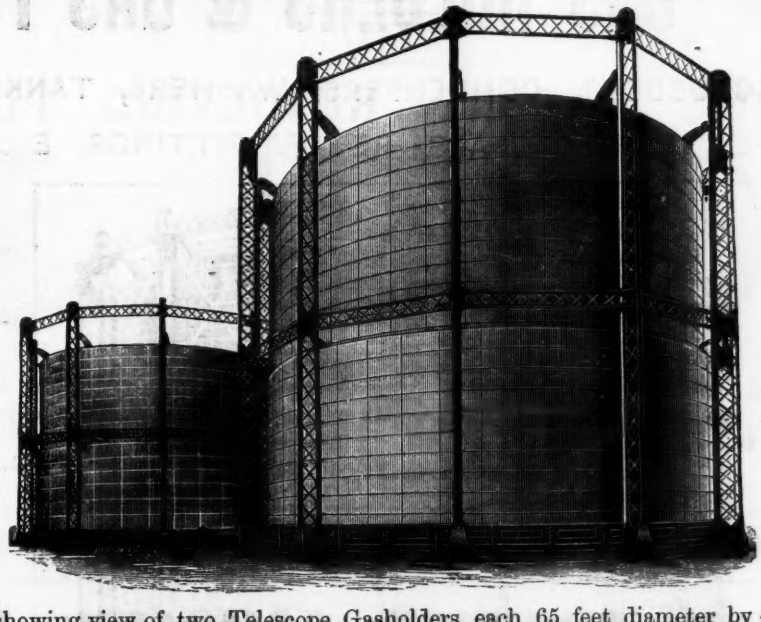

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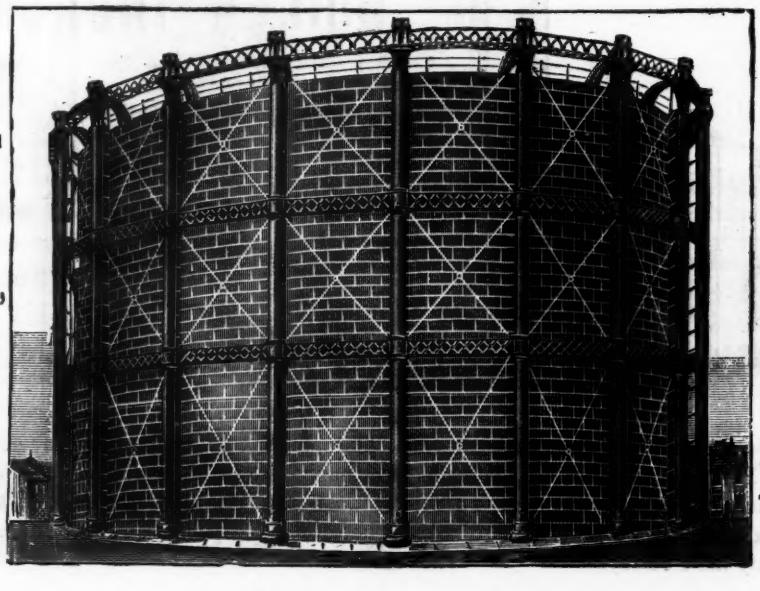

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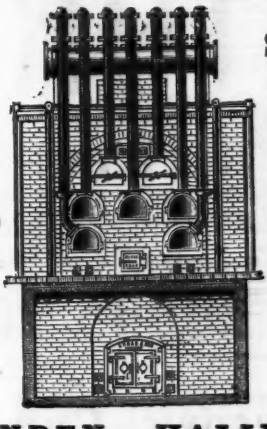

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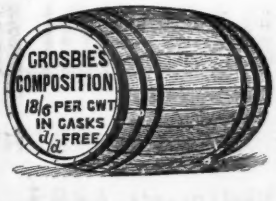

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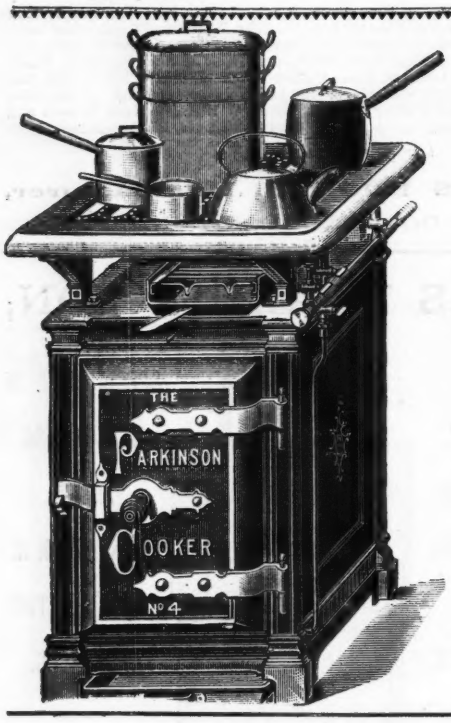

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THE NEWEST PATTERN COOKER INTRODUCED.

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Gives a powerful top heat.

Double Grill of simplest and most efficient kind.

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WITHOUT MECHANICAL ACTION.

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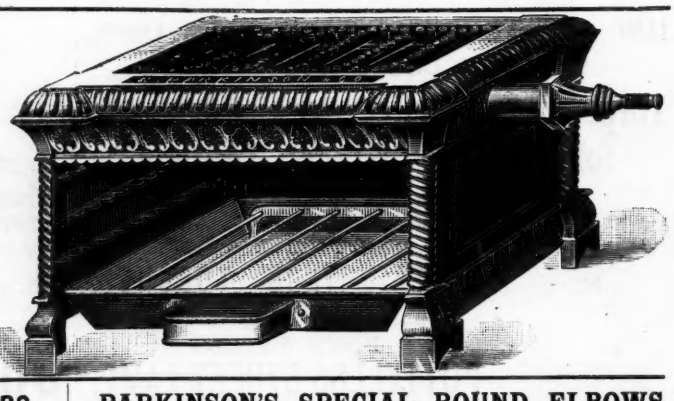

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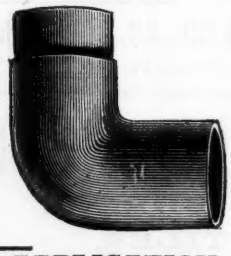

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[See also Advt., p. 1218.

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